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Published, February, 1884.



# INDIAN TERTIARY & POST-TERTIARY VERTEBRATA.

## ADDITIONAL SIWALIK PERISSODACTYLA & PROBOSCIDA.

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(WITH PLATES I. to V.)

### INTRODUCTORY.

Since the publication of the supplementary memoir on Siwalik Proboscida, and the memoirs on the *Rhinocerotidae* and *Equidae* in the preceding volume of this work, other remains of these groups from the Siwaliks have been acquired by, or lent to, the Indian Museum. Some of these later acquisitions belong to one or more new species; others to a species new to India; while others illustrate more fully than heretofore a previously known Indian species.

In the present memoir the most important of these new specimens are described and figured; and in order to illustrate their affinities more fully, the figures of certain specimens from the earlier volumes have been reproduced by the side of those of the new specimens.<sup>1</sup>

Since lists of species, together with the chief dental characters of the genera treated of in this memoir, have been already given in the two preceding volumes, the description of the species may be undertaken without preliminary matter.

It will save space to mention here that, with the exception of the remains of *Hippotherium*, the whole of the specimens<sup>2</sup> forming the subject of the present memoir were collected in 1882 by Mr. W. T. Blanford from the lower Siwaliks, or Manchhars, of the extreme western side of India; the two most important localities being Gandoi, in the Búgti Hills, north of Jacobabad, in Sind; and Dera Búgti, on the north-eastern frontier of Balúchistán.

<sup>1</sup> An additional reason for reproducing some of these figures was their unsatisfactory execution.

<sup>2</sup> These do not of course include the specimens from the tertiaries of other districts figured to illustrate more fully the affinities of Mr. Blanford's specimens.



ORDER: UNGULATA.<sup>1</sup> SUB-ORDER: PERISSODACTYLA.

FAMILY: RHINOCEROTIDÆ.

GENUS: ACERATHERIUM, Kaup.

Species: ACERATHERIUM BLANFORDI, n. sp., *nobis*.

*History*.—In the preceding volume of this work a much battered left maxilla of a small rhinoceros from the Siwaliks of the Punjab, containing pm. 4, m. 1, and m. 2, is figured<sup>2</sup> and briefly described.<sup>3</sup> It was there pointed out that the specimen apparently came nearest to *R. palæindicus*, among the Siwalik rhinoceroses; and that if not the same, it indicated a new Siwalik species: it was, however, added that there did not seem "any evidence at present to warrant us in separating the two," and the Punjab specimen was, therefore, provisionally referred to *R. palæindicus*.

The evidence for the specific distinctness of the form to which this imperfect specimen belonged has been afforded by the more perfect specimens forming the subject of the present notice.<sup>4</sup>

*Upper molars of larger race*.—In plate I., fig. 1, there are represented the three left upper true molars of a rhinoceros from Dera Būgti; in which the well-worn condition of the masticating surface indicates that they belonged to a fully adult animal: the first and third teeth are somewhat damaged, but the middle tooth is perfect.

The latter tooth (of which another specimen from Gandoi, in a less worn condition, is represented in fig. 2 of the same plate) is characterized by the comparatively small development of the buttress<sup>5</sup> at the antero-external angle; so that the second costa (*c*) projects but slightly above the plane of the external surface (*dorsum*) of the crown; while the external surface of the first costa (*d*) is placed very nearly in the same plane. Behind the second costa the dorsum is distinctly concave, especially near the free edge, but this concavity is much less marked than in many species.<sup>6</sup> The crown is worn into an irregular concavity, as in most rhinoceroses. The anterior collis (*a*) is relatively large; and at a short distance from its inner extremity is constricted by a deep groove on either side. On the outer side of the hindmost of these grooves there is a bold ante-crochet (*f*), projecting into the median valley; the bottom of which is thus completely obstructed in the middle. Externally to this obstruction the median valley again expands and deepens; the form of the terminal portion being rounded in all early stages of wear.

<sup>1</sup> In accordance with the classification recently proposed by Prof. Flower ('*Pro. Zool. Soc.*,' 1883, pp. 184-5) the Proboscidea will be reckoned as a sub-order of the Ungulata.

<sup>2</sup> Plate VI., fig. 1.

<sup>3</sup> Pages 44-45.

<sup>4</sup> These specimens have been briefly noticed in the "Records" (vol. XVI., p. 72), when it was thought the mandible resembled that of the African species, which turns out not to be the case.

<sup>5</sup> For these terms see vol. II., p. 8.

<sup>6</sup> This concavity is most marked in the specimen represented in fig. 2.

At the entrance to the same valley there is a large, blunt tubercle (*g*) attached exclusively to the posterior collis (*b*). The latter gives off a blunt projection into the median valley, placed a short distance internally to the ante-crochet (*f*), and more externally a distinct, though small crochet (*e*): there is no combing-plate at the extremity of the median valley. The posterior valley (*i*) is elongated antero-posteriorly, and is much less deep than the median valley; the descent from its outer wall being gradual. The cingulum forming the anterior valley (*left of a*) does not extend beyond the inner half of the tooth; and in one specimen (fig. 2) stops short of the inner surface of the anterior collis, but in the other extends a short distance on to this part.

In the last molar (m. 3, fig. 1) the general characters are the same as in the preceding tooth: the anterior cingulum extends, however, still more on to the inner face of the anterior collis (*a*), and the tubercle at the entrance to the median valley is larger. The much worn first molar (m. 1, fig. 1) shows the median valley all but divided by the above-mentioned obstruction into two distinct portions, the inner of which is triangular, and the outer sub-elliptical in shape. An equally worn m. 1 from Gandoi represented in plate II., fig. 2, exhibits these characters still more clearly.

*Upper cheek-teeth of smaller race.*—In plate II., fig. 4, there is represented the left maxilla of a smaller rhinoceros from Gandoi, containing all the permanent cheek-teeth, with the exception of pm. 1, in a medium condition of wear; the first and last of the series being somewhat damaged. With the exception of their considerably smaller size the true molars of this specimen agree precisely with the teeth described above; and since there is a considerable variation in the size of different races of some of the existing species of rhinoceros, there appears no good reason for regarding the Gandoi specimen otherwise than as belonging to a small race of the species to which the larger teeth belong.

The premolars of this specimen have their inner halves surrounded by a complete, sharp-edged cingulum; whose free edge extends much higher up on the crown of the posterior (*b*) than on that of the anterior collis (*a*). The latter extends considerably more inwardly than the former; which is, so to speak, buried in the cingulum. With the exception that the ante-crochet is less developed, the other general characters of the premolars are similar to those of the true molars. In pm. 4 there is a small combing-plate.<sup>1</sup>

*Comparisons with other Siwalik rhinoceroses.*—A comparison of the figures of the specimens described above with the small maxilla represented in vol. II., pl. VI., fig. 1, will show pretty clearly that all belong to the same species, the Punjab specimen being intermediate in point of size between those figured in this volume. Accepting this identification, it remains to show in what respects these specimens differ from *Rhinoceros palæindicus*, with which, in the perhaps over anxiety to avoid making unnecessary species, the first specimen was provisionally classed. In the

<sup>1</sup> There is another specimen of the same size from Gandoi in the Indian Museum (No. C. 266), exhibiting the three true molars of the right side in a much damaged condition.

true molars of the typical *R. palæindicus* (woodcut fig. 1<sup>1</sup>) the external surface is still



Fig. 1. *Rhinoceros palæindicus*, Falc. and Caut. 2nd upper true molar, from the Siwaliks: British Museum (No. 39,648): the tooth really belongs to the right side, but the figure has been reversed, so as to make it correspond with the teeth figured in plate 1. }

flatter than in the present specimens; the buttress being entirely absent and the costæ (*c*, *d*) but faintly developed. The bases of the two colles (*a*, *b*) are, moreover, in contact, and there is no tubercle at the entrance to the median valley (*g*): nor is there any ante-crochet. In more worn teeth<sup>2</sup> the median valley becomes separated into two isolated fossettes<sup>3</sup>; the entrance to the valley becoming obliterated, instead of having the triangular, imperfectly isolated fossette which occupies that place in the teeth under consideration (pl. II., fig. 2). The tooth regarded as a premolar of *R. palæindicus* (vol. II., pl. VII., fig. 2) is quite different from the premolars of the specimen represented in pl. II., fig. 4, of this volume.

In the preceding volume<sup>4</sup> a skull of a small Siwalik rhinoceros in the British Museum (No. 48,932) was provisionally referred to *R. palæindicus*. The inner halves of the molars (which are alone preserved) differ, however, from those of that species by the separation of the bases of the colles, and the partial development of an ante-crochet: *pm. 4* has, moreover, a distinct cingulum. Now that the specimen represented in vol. II., pl. VI., fig. 1, has been shown to be distinct from *R. palæindicus*: it seems pretty certain that the above-mentioned skull is likewise distinct. The last premolar of the latter is very like the corresponding tooth of the specimens under consideration; but the true molars have not such a marked ante-crochet and constriction of the anterior collis; and it, therefore, seems not improbable that this skull is likewise specifically distinct from the specimens under consideration, although the broken condition of its teeth does not admit of certain specific determination. Apart from the question as to the species of this skull it may be taken as pretty certain that the specimens under consideration do not belong to *R. palæindicus*; which is also distinguished by its greatly superior size.

Turning to *R. sivalensis*, it will be seen from the typical upper molar refigured

<sup>1</sup> This specimen is also figured ( $\frac{1}{2}$ ) in volume I., pl. IV., fig. 3, and in the "F.A.S.," pl. LXXV., fig. 4, as a premolar: it has been shown in vol. II. (p. 44) to be a true molar. The position in which this specimen is figured shows scarcely any of the external surface, which is well displayed in the specimens figured in the plates.

<sup>2</sup> "F.A.S.," pls. LXXIV., fig. 1: LXXV., fig. 1.

<sup>3</sup> In the previous volume (p. 44), from the inclusion of other specimens with this species, it was doubted whether this was invariably the case.

<sup>4</sup> Page 45.

in plate I., fig. 7, that the buttress is much more strongly developed; the second costa (c) standing out more prominently, and the first costa (d) being placed more internally to the plane of the external surface of the crown, and more prominently developed. Again, the anterior collis (a) has no vertical groove on its posterior side, and the ante-crochet (f) is absent: the crochet (e) is also relatively larger, and the outer termination of the median valley in an early stage of wear<sup>1</sup> is triangular, instead of rounded. The posterior valley (i) of *R. sivalensis* forms a deep, round pit, instead of a shallow, elongated pit; while there is no tubercle at the entrance to the median valley (g). The figures of the more worn teeth of *R. sivalensis* given in the 'F.A.S.'<sup>2</sup> show that the fossettes formed on their crowns are quite different from those of the Búgti specimens. The premolars of the former species<sup>3</sup> are, moreover, quite distinct from those of the latter, having no cingulum on the inner side, and a well-developed second costa.

These comparisons leave no doubt of the well-marked distinctness of the present specimens from the typical race of *R. sivalensis*. In the second volume,<sup>4</sup> however, a right upper molar from Sind was described, presenting certain differences from the typical teeth of the last-named species; but apparently not such as, in the absence of other evidence, could be taken to justify specific distinction. This specimen is refigured in plate I., fig. 3. In the general contour of the crown, especially in the well-developed buttress and costæ, this tooth agrees with the typical molar of *R. sivalensis*. It differs, however, in that there is a groove on both sides of the anterior collis (a), with the consequent formation of a small ante-crochet; by the elongated and shallow form of the posterior valley (i); and by the presence of a rudimentary tubercle at the entrance to the median valley (g). In the same volume<sup>5</sup> another upper molar, of considerably smaller size, but presenting the same external contour of the crown, was described, and provisionally referred to *R. sivalensis* under the separate varietal name of *gajensis* (so named from the Gáj beds, in which it was found). This specimen is refigured in plate I., fig. 4. In this tooth the characters in which the last specimen differed from the typical molar of *R. sivalensis* are exaggerated; the ante-crochet being very distinct; the posterior valley (i) much elongated; and the tubercle at the entrance to the median valley (g) distinctly developed.

If the tooth represented in pl. I., fig. 3, had not been known, the Gáj tooth would have been certainly referred to a distinct species: but as the former, which in future it may be convenient to refer to as *R. sivalensis*, var *intermedius*, is precisely intermediate between the latter and typical teeth of *R. sivalensis*, it was found advisable to provisionally regard the three as races, or varieties, of the same species: this conclusion being strongly confirmed by the circumstance that the teeth regarded as the milk-molars of *R. sivalensis*<sup>6</sup> closely resembled the Gáj tooth.

It will be observed that the molars of *v. intermedius* and *v. gajensis* resemble the

<sup>1</sup> Compare pl. I., fig. 2, with fig. 7; these specimens being in nearly the same stage of wear.

<sup>2</sup> Plates LXXIV., fig. 5; LXXV., fig. 5.

<sup>3</sup> *Supra.*, vol. II., pl. V., fig. 6.

<sup>4</sup> Page 30.

<sup>5</sup> Page 40.

<sup>6</sup> Vol. II., pl. VI., fig. 2.

Búgti teeth much more closely than do those of the typical *R. sivalensis*. They are, however, at once distinguished by the greater development of the buttress and costæ; which stamp them as of the *R. sivalensis* type. The premolars of *v. intermedius* and *v. gajensis* are unfortunately unknown. The further consideration of the mutual relations of all these forms will come more conveniently in the sequel.

The molars of *Aceratherium perimense*, of which a specimen is represented in plate I., fig. 5 in nearly the same stage of wear as m. 2 in fig. 1 of the same plate, are distinguished from the Búgti teeth by the much greater development of the buttress and costæ (*c*, *d*), and the more marked sinuosity of the external surface of the crown. The ante-crochet (*f*) is less developed, and does not so completely block the median valley; while the posterior valley (*i*) forms a deep funnel-shaped pit, in place of a slit. The tubercle (*g*) at the entrance of the same valley is, moreover, attached to both colles (*a*, *b*); and in some instances<sup>1</sup> is crenulated; while there is no vertical groove on the anterior face of the posterior collis (*b*). The premolars of *A. perimense*<sup>2</sup> resemble the Búgti teeth in the presence of a cingulum; but are distinguished by the circumstance that this cingulum, which is frequently crenulated, does not extend across the inner face of the posterior collis; by the larger development of the second costa (*c*); and by the greater proportionate increase in the size of the later teeth of this series. *A. perimense* is also distinguished by its much larger size.

To the molars of *R. platyrhinus*<sup>3</sup> the Búgti teeth present no resemblance; and it is therefore apparent that they cannot be referred to any of the previously described species of Siwalik rhinoceroses. Further comparisons will be instituted in the sequel.

*Mandible*.—In figure 5 of plate II. there is represented a fragment of the left ramus of the mandible belonging to the same individual as the upper molars represented in fig. 4. The inner side shows the commencement of the symphysis immediately in advance of the socket of pm. 3. Another specimen from Gandoi (woodcut fig. 2); which from its resemblance to the last specimen, and the locality

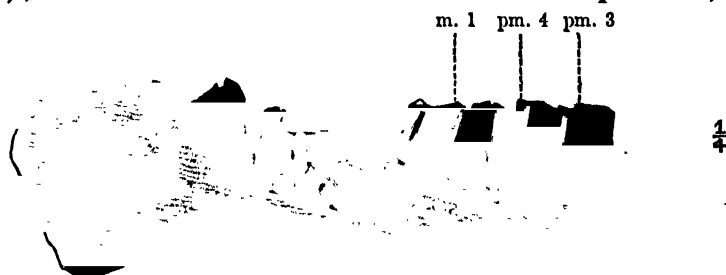


Fig. 2. *Aceratherium blanfordi*, Lyd. The right ramus of the mandible; from the lower Siwaliks of Gandoi: Indian Museum (No. C. 271).

from which it was obtained should almost certainly be referred to the larger race of the same species, shows a considerable part of the symphysis, and the alveolus of the right canine: while a third specimen from Gandoi (*Ind. Mus.*, No. C. 272) shows the hinder part of the symphysis, and the rami of both sides: the teeth and their alveoli and the extremity of the symphysis are, however, wanting. A fragment of

<sup>1</sup> *Supra.*, vol. II., pl. II.

<sup>2</sup> *Ibid.*, pls. II., III.

<sup>3</sup> *Ibid.*, pl. VIII.

the right ramus of a calf, with one milk-molar remaining, is represented in plate II., fig. 3. The lower molars have a faint trace of an external cingulum. The inferior border of the horizontal ramus is markedly convex: and the ramus itself diminishes rapidly in vertical height towards, and at the symphysis,<sup>1</sup> indicating that the form of this part was very similar to that prevailing in the existing Javan rhinoceros, and that the canines<sup>2</sup> were of moderate size;—an inference rendered certain by the size of their alveoli in the specimen in which these are preserved. In the specimen figured in the woodcut the crown of m.2 has been hammered off; while m.3 is only partially protruded.

*Upper milk-molars.*—In figure 6 of plate I. there are represented the first and second right upper milk-molars of a rhinoceros from Gandoi, which may in all probability be referred to the present species. These teeth are of considerable importance in confirming the conclusions already arrived at as to the distinctness of the latter, since four other different types of upper milk-molars have been already described and referred to the four other Siwalik rhinoceroses.<sup>3</sup> The present specimens may be at once compared with the others, without preliminary description. In *R. palæindicus*<sup>4</sup> mm.1 is more squared, and the anterior collis (*a*) is not distinctly developed: mm.2 has no obstruction at the entrance to the median valley; and the extremity of the latter is cut off as an isolated fossette, which is not the case with the present specimen: minor differences will be detected by a comparison of the figures. In *R. sivalensis*<sup>5</sup> the external surface of mm.2 is more convex, and wants the distinct costa which occurs opposite the median valley in mm.2 of the present specimen<sup>6</sup>: the tooth which is probably mm.1 of *R. sivalensis*<sup>7</sup> has a square crown, without any anterior prolongation. To mm.2 of *R. platyrhinus*<sup>8</sup> the corresponding tooth of the present specimen has no resemblance. In *Aceratherium perimense*<sup>9</sup> mm.2 has a squarer crown, with the two colles shaped more like those of the succeeding teeth: the median costa is also more strongly developed.

In figure 1 of plate II. there is represented the unworn germ of a right upper molar of a rhinoceros from Gandoi, which may possibly be the last milk-molar of the present species. It has lost the enamel of the anterior surface, and the first costa. The buttress was apparently more developed than in the true molars, giving the tooth a great resemblance to the molar of *R. sivalensis*, var. *gajensis*; from which it is, however, distinguished by its higher crown. The tooth has also a strong resemblance to mm.4 of *R. sivalensis*, but has likewise a higher crown. If the serial and specific determination of this tooth be correct it indicates a resemblance between the milk-teeth of the typical *R. sivalensis*, of var. *gajensis*, and the present species, not existing in the true molars.

<sup>1</sup> Seen even in the specimen represented in plate II., fig. 5, which is associated with the upper teeth of fig. 4.

<sup>2</sup> Since it is now pretty clearly proved that the outer mandibular cutting teeth of the rhinoceroses are canines, and not incisors, they will in future be so termed.

<sup>3</sup> Even if any of these milk-molars be wrongly assigned, this will not interfere with the inference drawn from the present specimens as to the existence of a fifth Siwalik rhinoceros.

<sup>4</sup> *Supra.*, vol. II., pl. VII., fig. 3.

<sup>5</sup> *Ibid.*, pl. VI., fig. 2.

<sup>6</sup> Not clearly shown in the figure.

<sup>7</sup> *Supra.*, vol. II., p. 34.

<sup>8</sup> *Ibid.*, pl. VII., fig. 4.

<sup>9</sup> *Ibid.*, pl. III., fig. 2: vol. I., pl. V., fig. 4.

*Further comparisons.*—Having now described all the known dental and mandibular remains of the present species; and its distinctness from the other named Siwalik species having been indicated; it remains to institute a wider range of comparisons. Commencing with the non-Siwalik Asiatic species, *R. deccanensis*<sup>1</sup> is distinguished by the absence of mandibular cutting teeth, and of an ante-crochet to the upper true molars, which are furnished with combing-plates. The upper premolars are, however, strikingly like those of the present species, but are distinguished by the greater development of the crochet, and the shape of the cingulum; which forms an inverted V, instead of an oblique line on the inner surface of the crown. The molars of *R. namadicus* are unknown. The last upper molar of the doubtfully distinct *R. sinensis*<sup>2</sup> has no ante-crochet.

Of the existing species, the large unicorn Indian rhinoceros is distinguished by its complex upper molars; while those of the Javan and Sumatran species<sup>3</sup> are of the *R. sivalensis* type. The two African species are distinguished by the absence of permanent cutting mandibular teeth; the same character also obtaining in *R. pachygnathus* of the Pikermi beds. The four species of the higher pliocene and pleistocene of Europe are likewise distinguished by the same character; as well as by the absence of pm. 1, which is shown by the specimen represented in plate II., fig. 4, to have been present in the Búgti species. It may be added that *R. tichorhinus*

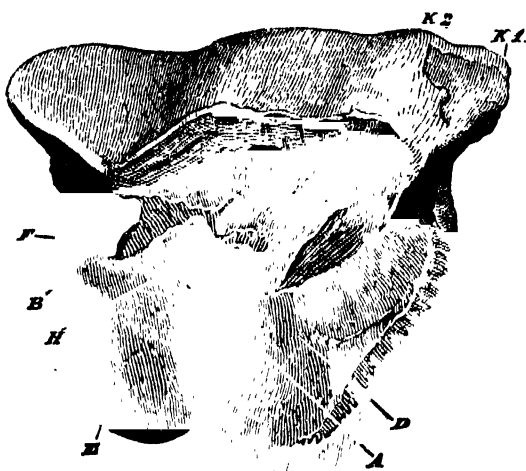


Fig. 3. *Rhinoceros megarhinus*,<sup>7</sup> Christol. Second right upper true molar, slightly worn. †. A, median valley; D, anterior collis; E, posterior do.; F, posterior valley; H, crochet; K 1, K 2, first and second costæ. Pleistocene, England.

is widely distinguished by the complex structure of its upper molars<sup>4</sup>; while in *R. megarhinus*<sup>5</sup> (woodcut fig. 3), and *R. leptorhinus*,<sup>6</sup> Ow., the upper cheek-teeth have not such a distinct ante-crochet, such a stout cingulum to the premolars, or such a distinct tubercle at the entrance to the median valley; the crochet is moreover always larger. In *R. etruscus*,<sup>8</sup> which Prof. Boyd Dawkins considers to be allied to the miocene forms, the upper premolars have a well-developed cingulum, and a distinct ante-crochet exists in the true molars. This species is, however, readily distinguished by the cingulum of the premolars being less prominent, and

running straight across the colles; both of which have the same inward extent. The

<sup>1</sup> *Supra.*, vol. I., p. 1, pls. I.—III.

<sup>2</sup> Owen, 'Quart. Journ. Geol. Soc.,' vol. XXVI., pl. XXIX., fig. 1.

<sup>3</sup> The so-called *R. lasiotis* and *R. inermis* are not distinguishable by dental characters from the Sumatran and Javan species.

<sup>4</sup> Owen, "Brit. Foss. Mamm. and Birds," fig. 122, p. 329.

<sup>5</sup> Lortet and Chantre, 'Arch. d. Mus. d'Hist. Nat. d. Lyon,' vol. II., pl. XVII.

<sup>6</sup> Owen, *op. cit.*, fig. 141, p. 373.

<sup>7</sup> The writer is indebted to Prof. Boyd Dawkins for this figure.

<sup>8</sup> Boyd Dawkins, 'Quart. Journ. Geol. Soc.,' vol. XXIV., pl. VII.

ante-crochet of the true molars is also smaller; and the crochet of m. 3 extends nearly, or completely, across the median valley.

As it will be shown below that the Búgti teeth almost certainly belong to an *Aceratherium*, it will be unnecessary to point out the differences between them and the molars of the other species of *Rhinoceros*; none of which resemble them very closely: and further comparisons may accordingly be confined to *Aceratherium*. In *A. incisivum*<sup>1</sup> the upper molars very closely resemble the larger Búgti teeth; the general plan of structure being precisely the same: the buttress is, however, somewhat more developed, the first costa placed more internally, the crochet larger, the tubercle at the entrance to the median valley generally less conspicuous, and the ante-crochet rather smaller in the European form; these differences being most conspicuous in an early stage of wear.<sup>2</sup> The premolars of the two are almost indistinguishable; and the fossettes formed on the well-worn molars are likewise precisely similar. The mandible presents, however, considerable differences in the two forms; the inferior border of the horizontal ramus of the European species<sup>3</sup> being straight, and the ramus itself preserving nearly the same vertical thickness throughout its length. The lower canines are much larger, and the cheek-teeth have a more distinct cingulum. Although these differences are in all probability of sufficient importance to indicate the specific distinctness of the two forms, yet the resemblances are so strong as to render it certain that they were extremely closely allied; and it may, therefore, be inferred that the Búgti rhinoceros was in all probability an *Aceratherium*.

It does not appear that the upper molars of any other European species of that genus approach as closely to the Búgti teeth: those of *A. lemanense*,<sup>4</sup> and *A. croizeti*<sup>5</sup> being distinguished by the larger buttress, and the absence of the crochet; and the lower molars of the former<sup>6</sup> having a strongly developed cingulum. In *A. goldfussi*<sup>7</sup> the upper molars have a conspicuous buttress, as in *A. perimense*: the ante-crochet is very slightly developed, and there is no tubercle at the entrance to the median valley of m. 3. *A. velaunum*<sup>8</sup> is readily distinguished by its shortened mandible, and the peculiar form of its lower molars. The upper molars of *A. minutum*<sup>9</sup> have a large buttress, and apparently no distinct tubercle at the entrance to the median valley.

In the so-called *R. austriacus*, Peters,<sup>10</sup> of the middle miocene of Styria, which

<sup>1</sup> Kaup, "Beiträge," pt. I., pl. IV. (the figure is very small, but being a photograph permits of enlargement with a lens: a cast of the original is in the British Museum). Blainville, "Ostéographie," Genus Rhinoceros, pl. XII. (*R. incisivus* de Sanson). The teeth in Kaup's specimen are slightly less worn than in the specimen represented in pl. I., fig. 1.

<sup>2</sup> Compare pl. I., fig. 2, with fig. 62 (p. 58) of "Les Enchainements du Monde Animal—Mamm. Tert.": the two teeth are in about the same stage of wear.

<sup>3</sup> Kaup, *op. cit.*, pl. 6.

<sup>4</sup> Blainville, "Ostéographie," Genus Rhinoceros, pl. XII. (*R. incisivus* d'Auvergne).

<sup>5</sup> Filhol, 'Ann. d. Sci. Geol.,' vol. XI., pp. 78-9.

<sup>6</sup> Gaudry, *op. cit.*, fig. 59.

<sup>7</sup> Kaup, *op. cit.*, pl. II. Gaudry, *op. cit.*, fig. 64 (*R. brachypus*).

<sup>8</sup> Filhol, "Mammifères Fossiles de Ronzon," pl. XII.

<sup>9</sup> Kaup, *loc. cit.*

<sup>10</sup> 'Denks. k. Ak. Wiss.,' vol. XXX., 1870, p. 46, pl. II. In the second volume of the present work this species is referred to *Rhinoceros*.



from the structure of its upper cheek-teeth probably belongs to *Aceratherium*, the upper premolars are readily distinguished from those of the Búgti species by the absence of an ante-crochet, the larger crochet, the more prominent second costa, the less complete cingulum, and the larger tubercle at the entrance to the median valley.

With regard to the American acerotheroids,<sup>1</sup> there is considerable difficulty in being perfectly sure that none of them are specifically the same as the Búgti form, owing to the circumstance that many of them have been only described in a preliminary manner, and that in many cases where figures have been given they are on such a small scale as to be useless for the detection of minute points of difference. It is, however, improbable that any one of the American forms should be specifically the same as an Indian species. Of those that have been figured the one that apparently comes nearest to the latter is *A. (Aphelops) fossiger*,<sup>2</sup> in which, as far as can be seen from the small figure, the upper molars have a very small buttress, and a large ante-crochet: but apparently no tubercle at the entrance to the median valley.

*Specific distinctness and affinities.*—As the result of the foregoing comparisons, it seems impossible to identify the Búgti rhinoceros with any described species; and it accordingly appears entitled to a separate specific name. The strong presumption that this species belonged to *Aceratherium* has been already indicated; and it is proposed that it should be known as *A. blanfordi*. The larger race may be distinguished as variety *majus*, and the smaller as variety *minus*. The remains of the former race indicate an animal somewhat exceeding in size full grown individuals of the typical Sumatran rhinoceros; while those of the latter are not larger than the small race of that form, which was named *R. niger* by Gray. As there is such an amount of variation in the size of the Búgti species, it has been thought that nothing would be gained by giving measurements. In the absence of the cranium it is impossible to say whether *A. blanfordi* was really hornless, but such was not improbably the case; although it is necessary to assume that those forms of the genus which come nearest to *Rhinoceros* were most probably furnished with a rudimentary nasal horn.<sup>3</sup> That the species was closely allied to *A. incisivum*<sup>4</sup> there can be no reasonable doubt; and there are also strong indications of its relation to the earlier races of the *R. sivalensis* type; a relationship of which traces are retained in the milk-molars of the later race of that type. It is, moreover, not impossible that the pleistocene *R. deccanensis* may have been a descendant from the same stock as *A. blanfordi*, since there is such a remarkable resemblance in the structure of their upper premolars. It is also conceivable that the small undetermined skull in the British Museum from the upper Siwaliks alluded to on page 4, may indicate a species connecting *A. blanfordi* with *R. deccanensis*, since there is a great similarity in the structure of their molars. The suppression of the buttress of the upper molars

<sup>1</sup> *Supra*, vol. II., pp. 20, 21.

<sup>2</sup> Cope, 'Amer. Nat.,' Dec., 1879, fig. 3, p. 771s.

<sup>3</sup> The writer is convinced that it is almost or quite impossible to draw any real distinction between *Aceratherium* and *Rhinoceros*.

<sup>4</sup> This species occurs in the Eppelshoim beds; and possibly in those of Pikermi and Mont Léberon.

which occurs in some of the most specialized recent and later tertiary rhinoceroses probably indicates that the stock of *A. perimense* (in which this buttress is strongly developed) diverged at an early stage from that of *A. blanfordi* (in which the buttress is small). It may be mentioned that the ante-crochet of the upper molars of the rhinoceroses is another feature which disappears in the later forms; being quite unknown in all those of the present day.

It thus seems probable that *A. incisivum*, *A. blanfordi*, and *R. sivalensis*, var. *gajensis* had a common ancestry in some part of the miocene; and that the latter form gave origin to var. *intermedius* of the lower Siwaliks, which overlie the Gáj beds, and that again to the typical *R. sivalensis* of the upper Siwaliks, from which the living Javan rhinoceros may have descended. The exact relationship of *A. blanfordi* to *A. incisivum* cannot yet be determined; neither is it certain in which direction the migration of the connecting forms took place. From the occurrence of the Gáj variety of *R. sivalensis* in the upper miocene of India, and that of *A. incisivum* in the upper miocene, and possibly in the lower pliocene, of Europe, and from the distribution of *A. blanfordi* (as noticed below), it seems, however, not improbable that the common ancestral form originated in the countries between India and Europe, and that the Styrian *A. austriacum* may be another branch of the same stock.

*Distribution*.—Remains of *A. blanfordi* have been obtained from the Punjab and the Búgti districts; and whereas the species appears to have been very rare in the former, it appears to have been as common in the latter area. This is noteworthy, since it would be expected that an Indian species exhibiting affinity with a European form would occur most abundantly on the western side of the Indian area.

A considerable part of the skeleton of the smaller race of the present species has been obtained and may perhaps form the subject of a future memoir.

#### FAMILY: *EQUIDÆ*.

#### GENUS: *HIPPOTHERIUM*, Kaup.

#### Species: *HIPPOTHERIUM ANTILOPINUM*, Falc. and Caut.

*Object of present notice*.—A large series of the remains of this species (together with those of *H. theobaldi*) have been described in the third part of the second volume of the present work; but at that time no specimen of the cranium was known. This desideratum has been supplied by the specimen forming the subject of the present notice; which has been already briefly alluded to in the 'Records' of 1883.

*Cranium*.—The cranium mentioned above is the property of Mr. Theodore Cooke, LL.D., F.G.S., of Poona, India, who has kindly lent it for description. It was obtained from the Siwaliks of Perim Island; and is represented, of half the natural size, in figures 1 and 2 of plate III.: the check-dentition of the left side

being represented of the full size in fig. 3 of the same plate. The specimen has lost its two extremities, the crowns of the cheek-teeth of the right side, and the outer walls of some of those of the opposite side, but is otherwise in excellent preservation; many of the cranial sutures being distinctly visible. The condition of the teeth shows that the skull belonged to a fully adult, though not an old individual.

The grinding surfaces of the teeth cannot be completely cleaned from matrix; although this has been accomplished sufficiently to exhibit the complete isolation of the anterior pillar (*e*),<sup>1</sup> characteristic of *Hippotherium*; as well as the complex plication of the dentine and enamel in the central part of the crown, which is especially well-marked in both the Indian species described in the second volume. The anterior pillar (*e*) is less prominent and less elongated in cross-section than in the teeth of *H. theobaldi* figured in the same volume<sup>2</sup>; while the posterior pillar (*f*) is not constricted at its junction with the inner column, as is the case in little-worn teeth of that species,<sup>3</sup> and is larger than in well-worn teeth of the same.<sup>4</sup> In all these respects the teeth of the Perim skull agree with those of *H. antilopinum*<sup>5</sup>; as well as with the isolated tooth from the Punjab of which a polished transverse section is represented in plate III., fig. 4, of this volume. In the following table the dimensions of the Perim skull are compared with those of the three maxillæ referred to *H. antilopinum* in the second volume<sup>6</sup>; viz.:

	Previous specimens.			Perim skull.
Width of palate posteriorly . . . . .			2.0	2.8
" " " between pm. 4 . . . . .			1.9	2.6
Length of series of cheek-teeth . . . . .	5.3			5.8
" " three true molars . . . . .	2.36		2.5	2.67
" " pm. 2 . . . . .	1.25			1.25
Width " " " . . . . .	0.83			
Length " " 3 . . . . .	0.96	0.96		0.96
Width " " " . . . . .	0.95	0.95		1.04
Length " " 4 . . . . .	0.93	0.9	0.9	0.92
Width " " " . . . . .	0.86	0.91	0.9	
Length " m. 1 . . . . .	0.8	0.81	0.8	0.88
Width " " " . . . . .	0.85	0.88	0.9	
Length " " 2 . . . . .	0.85	0.82	0.8	0.87
Width " " " . . . . .	0.76	0.72	0.85	0.93
Length " " 3 . . . . .	0.8		0.85	0.98
Width " " " . . . . .	0.55		0.75	0.83

It will be observed that the teeth and palate of the Perim skull are somewhat larger than those of either of the other specimens, although the teeth are still considerably smaller than those of *H. theobaldi* figured in the second volume. It will also be observed that in the Perim skull the length of pm. 3 is less than its width, the reverse being the case in the other three specimens. Analogous differences prevail, however, in the latter, since the length of pm. 4 of the specimen in the first column exceeds its width, the reverse prevailing in the other two specimens: these differences need not,

<sup>1</sup> For the terms employed in the description of the cheek-teeth of the horses, see vol. II., p. 73.

<sup>2</sup> Plate XI., fig. 3.

<sup>3</sup> *Ibid.*

<sup>4</sup> Vol. II., pl. XIII., fig. 2.

<sup>5</sup> *Ibid.*, pl. XI., fig. 1. "F.A.S.," pl. LXXXIII., fig. 18.

<sup>6</sup> Page 76.

therefore, be of more than individual value, if all the three first specimens are correctly referred to the same species.

It appears from the foregoing comparisons and measurements that the Perim skull agrees so nearly with *H. antilopinum* that there seems no reason for assigning it to another species<sup>1</sup>; although its large size tends to remove one of the distinctions between that species and *H. theobaldi*.

Accepting the provisional reference of the skull under consideration to *H. antilopinum*, its distinctive characters will be exhibited in the best way, by at once comparing it with the skull of *H. gracile*. Regarding the teeth, no more need be said except that there are no signs of the presence of pm. 1; which exists as a small tooth in some specimens of *H. gracile*: this absence is the more remarkable since this tooth persists in both the Siwalik species of *Equus*. The Perim skull agrees with that of its European congener<sup>2</sup> in its comparatively small size; as well as in its general contour, and absolute size. The two skulls also agree in the presence of two cavities in the outer surface of the maxilla, one of which (*a*) may conveniently be termed the anterior, and the other (*b*) the posterior maxillary cavity. There is, however, a very great difference in the shape and position of the former cavity in the two skulls. In *H. gracile* the posterior, or so-called larmial, cavity is very large, extending backwards as far as the anterior border of the lachrymal, or within less than an inch from the anterior border of the orbit, and having a long diameter of more than three inches. The infra-orbital foramen (*trous sous-orbitaire*) is described by Prof. Gaudry<sup>3</sup> as "*situé, soit a la partie antérieure du larmier, soit en dehors et un peu en avant.*" In the Perim skull, on the other hand, the corresponding cavity (*b*) is comparatively small, and separated by a considerable interval from the anterior border of the lachrymal (*la*), and by a space of two-and-a-half inches from the orbit, its longer diameter being about one-and-a-half inches. The infra-orbital foramen commences at the hinder extremity of the posterior cavity; the latter having merely the appearance of a much dilated aperture of the foramen. The same cavity extends some distance on to the outer surface of the nasal. In advance of the posterior cavity there is a broad, shallow, groove on the surface of the maxilla, conducting to the anterior maxillary cavity (*a*), which is a deep spherical depression immediately in advance of pm. 2. The corresponding cavity<sup>4</sup> in *H. gracile* is considerably longer and shallower; but was apparently connected with the posterior cavity by a similar groove, which the crushed condition of the Pikermi skull has to a great extent obliterated. According to Prof. Gaudry<sup>5</sup> distinct traces of this anterior cavity may be seen in the skulls of *E. burchelli* and

<sup>1</sup> Seeing that if the broken maxillæ of the existing species of African horses were mingled together it would probably be quite impossible to refer them to more than one species, it is highly probable that the teeth and maxillæ referred to *H. antilopinum* really belong to more than one closely allied species. In the absence, however, of any certain points of specific distinction, the only course at present is to refer them provisionally to the same species, or group, if the latter term be preferred.

<sup>2</sup> Gaudry, "Ann. Foss. et Géol. de l'Attique," pl. XXXV.: by the courtesy of Prof. Gaudry the writer has been enabled to compare the Perim skull with a cast of the Pikermi specimen.

<sup>3</sup> *Op. cit.*, p. 222.

<sup>4</sup> Marked *d* in Prof. Gaudry's figure.

<sup>5</sup> *Op. cit.*, p. 222.

*E. quagga*; and they may also be detected in some skulls of *E. caballus*, where the groove occurring in advance of the infra-orbital foramen not unfrequently terminates above pm. 2 in a very shallow, but distinct depression.

The smooth form of these cavities in the Perim skull leaves little or no doubt that they once contained a sebaceous gland, like the 'larmier' of the deer and antelopes. In all deer and in most antelopes the larmier is single, and placed almost entirely in the lachrymal; having of course no connection with the infra-orbital foramen. In some antelopes, however (e.g., *Cephalopus maxwelli*, and *C. pygmaea*)<sup>1</sup> a similar cavity is present in the maxilla, which sometimes coexists with the lachrymal cavity, and sometimes replaces it. "In the African water-hogs [*Potamochoerus*] a naso-maxillary pit opens between the eye and snout, rather nearer the eye."<sup>2</sup> In *Oreodon*<sup>3</sup> there is a single cavity which is confined to the lachrymal.

These observations indicate pretty clearly that the maxillary cavities of *Hippotherium* are homologous with those of the Artiodactyla; and are very noteworthy as being one of the very few evidences among the later forms of an original connection between the artiodactyle and perissodactyle modifications of the Ungulata.

The differences in the form of the posterior maxillary cavity in *H. antilopinum*, and *H. gracile* are so great as to leave no question of the specific distinctness of those forms, of which, from the study of the remains then available, some doubt was entertained in the second volume. The diminished size and more advanced position of the same cavity in *H. antilopinum* indicates that this species should be regarded as a form between the European species, and the modern horses; of which the African species retain most traces of their connection with the hippotheres. If the writer's memory serves him correctly, the posterior larmial cavity in the young maxilla of *H. theobaldi* from the Punjab, briefly mentioned in the second volume,<sup>4</sup> is of much larger size, and placed considerably nearer to the orbit than in the Perim skull.

The latter does not appear to differ in any other important points from the European species.

*Distribution.*—The specimen under consideration extends the range of the species to Perim Island; of which there was only some doubtful evidence at the time of publication of the second volume.

Species: *non. det.* (? *nov.*)

*Upper molars.*—In the accompanying woodcut (fig. 4) there are represented three associated right upper cheek-teeth of a species of *Hippotherium* lately obtained

<sup>1</sup> See Owen, "Anatomy of Vertebrates," vol. III., p. 633.

<sup>2</sup> Owen, *op. cit.*, p. 634.

<sup>3</sup> Gaudry, "Les Enchainements—Mam. Tert.," fig. 90, p. 81.

<sup>4</sup> Page 83. The specimen is No. C. 163, Indian Museum; and the present writer would be obliged to any officer of the G. S. I. who would compare it with the figure of the Perim skull, and communicate the result to the "Records."

by Mr. F. Fedden from the Siwaliks of Perim Island. The crowns of the molars

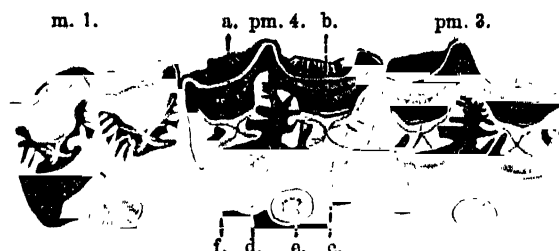


Fig. 4. *Hippotherium* sp. (n. nov.). Polished section of three right upper cheek-teeth, in a fragment of the maxilla; from the Siwaliks of Perim Island, Gulf of Cambay: Indian Museum (No. C. 273).

were so encrusted with matrix that it was found impossible to cleanse them, and the specimen has accordingly been ground and polished. The structure of the teeth shows that they undoubtedly belong to a *Hippotherium*; and from the two first teeth being larger than the third, and less fully protruded, it is evident that the

former are the two last premolars, and the latter the first true molar.

In the following table the dimensions of these three teeth are compared with those of the corresponding teeth of *H. theobaldi* figured in the second volume,<sup>1</sup> viz. :—

	<i>H. theobaldi.</i>	Specimen.
Length of three teeth . . . . .	3·3	3·03
„ „ pm. 3 . . . . .	1·24	1·06
Width „ „ „ . . . . .	1·12	1·0
Length „ „ 4 . . . . .	1·13	1·05
Width „ „ „ . . . . .	1·15	1·01
Length „ m. 1 . . . . .	1·0	0·94
Width „ „ „ . . . . .	1·05	0·05

The united length of the corresponding teeth of the Perim skull of *H. antilopinum* described above is 2·23 inches; and the present specimen is, therefore, nearer in point of size to *H. theobaldi*. Compared with the slightly worn teeth of that species represented in vol. II., pl. XI., fig. 3, the present teeth differ by the section of the anterior pillar (e) being sub-circular, instead of markedly ellipsoidal, this character being most marked in the premolars: but agree in having the posterior pillar (f) connected with the adjacent inner crescent (d) by a constricted neck: the shape of this pillar differs, however, considerably, being elongated in *H. theobaldi* and rounded in the present specimen. In more worn teeth of *H. theobaldi*<sup>1</sup> this pillar becomes almost completely merged with the first inner crescent (c); which would apparently never be the case with the present teeth.

In *H. antilopinum*<sup>2</sup> (as in *H. gracile*) the posterior pillar of the upper cheek-teeth is always well developed, and never shows a constricted junction with the adjacent crescent, except in a very early stage of wear: the anterior pillar has much the same shape and position as in the specimen under consideration. In none of the known examples of *H. antilopinum*<sup>3</sup> does the length of pm. 3 exceed its width by so much as in the present specimen. Finally, the teeth of the latter are considerably larger than those of *H. antilopinum*. In the detached tooth represented in plate III., fig. 4, of this volume, which exhibits all the characters of *H. antilopinum*, the line of section is taken at precisely the same level as in the specimen under consideration; and as

<sup>1</sup> Vol. II., pl. XIII., fig. 1.

<sup>2</sup> Vol. II., pl. XI., fig. 1: 'F.A.S.', pl. LXXXII., figs. 13, 16, 18: and pl. III., fig. 3, of the present volume.

<sup>3</sup> See table on page 12.

the two specimens are from the same side of the jaw, they are excellently adapted for exhibiting the characteristic differences.

As the result of the foregoing comparisons, the present writer (although fully aware of the difficulty of distinguishing the horses solely by means of their dentition) is very strongly of opinion that the teeth under consideration indicate a third Siwalik *Hippotherium*, intermediate in size between the other two species. It was shown in the second volume<sup>1</sup> that a lower jaw from the Punjab provisionally referred to *H. theobaldi* differed in some respects from the type specimen, and it is possible that it may belong to the same form as the upper molars from Perim.

The latter are distinguished from the upper teeth of *H. gracile* in much the same respects as from those of *H. antilopinum*. It appears, moreover, that in all the Indian species the plications of the dentine and enamel are decidedly more complex than in the European species; this character being especially noticeable in well-worn teeth.<sup>2</sup>

The writer has been unable to identify the Perim teeth with any of the American species. They are markedly distinct from *H. calumarium*,<sup>3</sup> in which the hinder pillar of the upper cheek-teeth is remarkably large; and they differ from *H. speciosum*<sup>4</sup> by their superior size, by the more cylindrical anterior pillar, and the greater complexity of the plications of the enamel.

*Specific distinctness.*—If further discoveries confirm the conclusion that the Perim teeth probably belong to a new species, the name *H. feddeni* may be appropriately applied.

*Affinities of the Siwalik species.*—The extreme complexity of structure of the molars of the Siwalik hippotheres, coupled with the absence of pm.<sup>1</sup> in at least one species, points to the conclusion that none of these species were on the direct ancestral line of *Equus*.

#### SUB-ORDER: PROBOSCIDIA.

*Nomenclature of the milk and premolar series.*—In the first volume of this work,<sup>5</sup> owing to the general absence in the Proboscidea of the first deciduous cheek-tooth of the typical eutherian series, the three teeth of this series which are normally developed in the elephantine family of that sub-order were, following Dr. Falconer, respectively termed antepenultimate, penultimate, and last, or more generally, first, second, and third. Although this nomenclature is convenient for the Proboscidea when considered by themselves, it is apt to lead to confusion when treating of the other sub-orders of the Ungulata,<sup>6</sup> and the rest of the Mammalia; and it, therefore, seems best to adopt the nomenclature of the typical eutherian series. In this

<sup>1</sup> Page 20, pl. XII., fig. 4.

<sup>2</sup> Compare the specimens figured in Gaudry's "Ann. Foss. et Géol. de l'Attique," pl. XXXIV., fig. 7.

<sup>3</sup> Cope, "Rep. U. S. Geog. Surv. W. of 100th Meridian," vol. IV., pt. II., pl. LXXV., fig. 1. This species is distinguished from the European and both the other Indian species by the want of the anterior projection of pm. 2.

<sup>4</sup> *Ibid*, fig. 3.

<sup>5</sup> Pp. 198-201.

<sup>6</sup> The discrepancy was not so marked when the Proboscidea were regarded as a group of equivalent value with the Ungulata.

memoir, therefore, the three milk-molars of the elephantine Proboscidea will be respectively termed the second, third, and fourth. The same rule will be applied to the premolars; the two teeth of that series usually present being respectively termed the third and fourth. This explanation will, it is hoped, obviate any confusion that might arise from this change of nomenclature.

FAMILY: *ELEPHANTIDÆ*.

GENUS: *MASTODON*, Cuvier.

*Number of Siwalik species.*—In the first volume of this work<sup>1</sup> five species of Siwalik mastodons were described; two belonging to the trilophodont, and three to the tetralophodont section of the genus. The specimens described in the present memoir indicate a third species of the former section; and illustrate rather more fully the dentition of the other Siwalik species of the same section.

*Additional American species.*—It may be mentioned that to the list of species of mastodons given in the first volume<sup>2</sup> there should be added the two following undescribed species, *viz.*:

*Mastodon (Tetralophodon) campester*, Cope.<sup>3</sup> Miocene; N. America.

*Mastodon proavus*, Cope.<sup>4</sup> Pliocene; N. America.

*New proboscidian genus.*—Since the publication of the same volume the tusk of a fossil proboscidian from the tertiaries of Australia has been described by Sir R. Owen,<sup>5</sup> under the name of *Notelephas australis*.<sup>6</sup>

*Distribution of Indian mastodons.*—A very remarkable circumstance in connection with the distribution of Indian mastodons is revealed by the specimens described in the sequel, and those already described in the first volume of this work. This circumstance is that tetralophodont forms are alone found in the typical eastern Siwalik Hills, and Burma, while on the extreme north-western side of India, trilophodont are the dominant, or sole, forms.<sup>7</sup> It is worthy of remark that *Pinotherium* occurs in the region occupied by the trilophodonts, while the true elephants are confined to the tetralophodont region, where the intermediate stegodonts also occur.

As the dinotheres are essentially European forms, and as there is an Indian species (*D. sindiense*) connecting these with the trilophodonts, while it will be shown in the sequel that there are good reasons for regarding at least two of the Siwalik trilophodonts as immigrants into India from the west, it is not impossible that the

<sup>1</sup> Pp. 202-256.

<sup>2</sup> P. 283.

<sup>3</sup> 'Pro. Amer. Phil. Soc.,' vol. XVII., p. 226, 1877: this species is said to be allied to *M. longirostris*.

<sup>4</sup> 'Rep. U.S. Geol. Surv.,' 1873, p. 531: this species is known only by one perfect tooth, and some broken teeth, and an astragalus: it is not stated whether it is a *Tetra-* or *Trilophodon*.

<sup>5</sup> 'Phil. Trans.,' 1882, p. 772.

<sup>6</sup> The present writer is fain to confess that he can see no reason for assigning the tusk in question to a new genus.

<sup>7</sup> *M. latidens* ranges into Sind: in Dera Būgti and the Būgti Hills no remains of tetralophodonts have been found.



dinotheres and trilophodons of the lower Siwaliks of the west of India were, if not the actual progenitors, at least closely connected with the ancestors, of the tetralophodons, stegodons, and true elephants of the upper Siwaliks of the eastern side of that country, although from the existence of *M. latidens* in the lower Siwaliks of Sind some of these transitions may have taken place in the regions to the west of India; the higher forms alone having migrated eastward.<sup>1</sup> It is quite possible to imagine that the tetralophodont *M. latidens*, with its short mandibular symphysis, may have taken origin from the trilophodont *M. angustidens*,<sup>2</sup> with its long symphysis; and the transition from the former to the stegodons and higher elephants has been shown in the first volume to be so extremely gradual and complete, that it is highly probable that the one may be the ancestor of the other.

If then, the true elephants took their origin from the stegodons characteristic of Eastern Asia there must either have been a subsequent western migration towards Europe; or, which is equally possible, the stream went continuously eastward *via* China, Japan, and America.<sup>3</sup> That there should be difficulties in some of the above-mentioned views (which are put forth merely in the light of suggestions for further thought) is but natural. Thus if the tetralophodons of India took their origin in that country from the trilophodons, how did the upper miocene tetralophodon of Europe (*M. longirostris*)<sup>4</sup> arise? Could the different tetralophodons have had separate origins from the trilophodons? If moreover true elephants originated in India during some part of the Siwalik period, there is some difficulty in seeing how they should have reached Europe by the time of the upper pliocene. These difficulties, however, though great, are not insurmountable; but before these views can be put into definite shape it requires a further knowledge of the proboscidiens of China and Japan; and some information regarding those of Persia and Asia Minor.

*Genealogy of the elephants.*—A few observations on the genealogy of the elephantine Proboscidea arising from the study of the specimens described in the sequel may be here recorded. The presence in some of the mastodons of simple tetraconodont premolars like those represented in pl. V., figs. 2 and 6, suggests the probability of the descent of these animals from some primal ungulate, furnished with teeth of this simple structure, in which the premolars were as fully developed as the molars. The replacement of the three-ridged last lower milk-molar of the pigs by a much simpler premolar, is very similar to the replacement of the corresponding upper tooth in the trilophodont mastodons by a tetraconodont

<sup>1</sup> The stegodons are known to extend to China and Japan; *Elephas namadicus* also occurring in that country.

<sup>2</sup> The ridges and valleys in this species are not quite so simple as in *M. latidens*; but there seems no reason why the modification in one direction may not have tended to simple, and in another to complex ridges.

<sup>3</sup> The association of *E. primigenius* with *E. namadicus* in Japan and the occurrence of the former in N. America is in favour of this view: and it has been shown in the previous volume that the migration of the machærodonts not improbably followed a similar course.

<sup>4</sup> The European tetralophodons (*M. longirostris*, *M. arvernensis*), from the very irregular ridges of their molars, cannot be looked upon as on the direct ancestral line of the true elephants.

premolar; and it is merely necessary to assume the addition of an extra pair of columns to each of the true molars of the bunodont Artiodactyla to produce a dentition analogous to that of the simple-toothed mastodons. What the primal ungulate may have been that gave origin to the Proboscida is at present unknown; that it was intimately related to some of the cocene ungulates of America is almost certain, from the resemblance of their foot-structure to that of the elephants: the dentition of the former indicates, however, that they are probably a branch which diverged at an early date from the proboscidian stock, and are more intimately connected in this respect with the modern Perissodactyla.

The mastodons, and still more the true elephants, may be regarded as animals retaining a very primitive type of skeleton, but whose dentition has reached a very high degree of specialization. The want of specialization in the skeleton may not improbably be due to the huge size of these animals, whereby they have obviated the necessity of modifications on the primitive type of skeleton, which are necessary to produce a limb capable of the rapid flight of animals like the horse and the antelope. Their dentition has been gradually increasing in specialization in order to make the utmost possible use of the diet on which these animals subsist.

The survival of the elephant in India, after so many highly specialized ungulates (e.g., *Sivatherium*) have entirely disappeared, seems to indicate the inherent vitality of a primitive form when once it has attained an amount of specialization in any direction (in this case in dentition, and corporeal bulk) to enable it to hold its own among other animals.

Species 1: MASTODON (TRILOPHODON) ANGUSTIDENS, Cuv.

Var. PALÆINDICUS, *novis*.

*First record of occurrence in India.*—It has been stated in the first volume<sup>1</sup> that some of the first-found mastodon remains from the Siwaliks were originally referred to *M. angustidens*, but were subsequently separated under the name of *M. sivalensis*. The only other notice referring to the occurrence of *M. angustidens* in India is one published in 1883<sup>2</sup> referring to some of the specimens forming the subject of the present description. All these specimens, with one exception, which will be noticed in the sequel, were obtained from Dera Būgti.

*Third lower true molar.*—In order to determine the serial position of the different teeth described in the sequel it has been found necessary to commence with the last teeth of the series; of which a specimen from the right side of the lower jaw is represented in plate IV., fig. 3. This tooth, which is in an intermediate stage of wear, was associated with the second upper true molar represented in figure 2 of the same plate: it carries four transverse ridges and a talon (*ta*); from which circumstance, together with the shape of the crown, and the concave form of the worn masticating surface, it is evidently the last lower molar of a trilophodont mastodon.

<sup>1</sup> Page 248.

<sup>2</sup> 'Records,' vol. XVI., pp. 161-2.

The transverse ridges are divided by a fissure traversing the long axis of the crown into inner and outer columns, which have a tendency to an alternate arrangement. Each of the valleys dividing the ridges is blocked by a large accessory column (*a*), placed on the posterior aspect of the transverse ridges, and extending across the median longitudinal fissure. When slightly more worn the dentine surface of each of these accessory columns would coalesce with that of the outer column immediately in front of it, and produce rudely trefoil-shaped dentine islets; and it is evident that in a somewhat earlier stage of wear the antero-internal angle of each of the outer columns (*b*) would have formed a separate smaller anterior accessory column. At the outer extremity of each of the transverse valleys there is a low, blunt tubercle; the separate tubercles being connected by a cingulum. The transverse valleys are comparatively wide at their extremities so that the ridges are not in contact. There is no trace of any cement.

Compared with the corresponding tooth of the Siwalik *M. pandionis*,<sup>1</sup> the present specimen will be found to differ very widely. In the first place, it is of considerably smaller size; while the ridges are lower, and the hind talon is single in place of double: the anterior talon seems also to have been smaller. The accessory columns of *M. pandionis* are much more numerous, being wedged in between the main columns of the ridges, and blocking the transverse valleys to a much greater extent than in the present specimen. The columns composing the transverse ridges in *M. pandionis* are moreover in close contact at their bases, so that the valleys become extremely narrow. The blunt tubercles occurring at the outer extremities of the transverse valleys of the present specimen are not distinctly developed in *M. pandionis*; and the worn dentine surfaces of the latter have no tendency to assume a trefoil shape. Finally, cement is present in large quantities in the molar of *M. pandionis*.

The corresponding molar of *M. falconeri*, the other Siwalik trilophodon, is unknown, but as it will be shown below that the other teeth of the Búgti mastodon are different, the present specimen cannot be referred to that species.

Compared with the last lower molar of *M. angustidens* the present specimen agrees very closely. A tooth of that species figured by H. von Meyer<sup>2</sup> is of precisely the same size, and has the same general contour of the crown, with the exception that the borders of the crown are less curved: and in other European specimens<sup>3</sup> these borders are still less curved. The arrangement of the ridges, and the form of the transverse valleys is exactly the same in the two; and there are the same blunt tubercles at the outer extremities of the transverse valleys. The hind talon of the European tooth is, however, more detached; and consists of only one column. The most important difference between the two teeth consists in the

<sup>1</sup> Vol. I., pl. XXXIV., fig. 2; XXXV., fig. 4: the second of these specimens agrees exactly in its degree of wear with the specimen under consideration, and from belonging to the same side, is very favourable for comparison.

<sup>2</sup> "Paläontographica," vol. XVII., pl. VII., figs. 3 and 4.

<sup>3</sup> Vucek, 'Abhand. k. k. geol. Reich.,' vol. VII., pt. 4, pl. IV., fig. 2.

greater development of the posterior accessory columns (*a*) in the Indian tooth. In the European tooth these are not larger than the anterior accessory columns (*b*), and do not extend on the outer side of the median longitudinal fissure; this causes the blocking of the middle of the transverse valleys to be less complete than in the Indian tooth. In some European specimens<sup>1</sup> the development of the posterior accessory columns is still less; but in others again<sup>2</sup> it is greater, although perhaps never quite so large as in the Indian tooth. There is a considerable degree of variation in the size of the hind talon in European specimens.

It appears, therefore, that the differences between the present specimen and the last lower molar of *M. angustidens* are scarcely, if at all, greater than those occurring between different European specimens of the latter; and it thus seems probable that at the most they should be reckoned merely as of varietal value. The greater development of the accessory columns in the Indian tooth is a step from the typical form of *M. angustidens* towards the more complex tooth of *M. pandionis*.

In the following table the dimensions of the present specimen are compared with those of the corresponding teeth of *M. pandionis*<sup>3</sup> and *M. angustidens*<sup>4</sup>; the specimens of the teeth of the two latter being in the same condition of wear as the Búgti tooth.

	Specimen.	<i>M. angustidens</i> .	<i>M. pandionis</i> .
Total length . . . . .	5.65	5.85	8.4
Greatest width of first ridge . . . . .	2.38	2.5	3.3
Height of first ridge . . . . .	1.0	1.0	1.8
„ „ hind talon . . . . .	1.35	0.8	2.6

A smaller tooth of *M. pandionis* has a length of 7.4 inches. The European molar of *M. angustidens* is an unusually small one.

*Second upper true molar*.—The tooth represented in plate IV., fig. 2, belonged to the same individual as the last specimen.<sup>5</sup> The regular oblong form of the crown shows that it belongs to the upper jaw; while the presence of but three ridges, which are more worn than those of the last lower tooth, shows that it must be the second true molar: it belongs to the left side of the skull. The tooth exhibits a large concavity on its anterior surface, caused by the pressure of the preceding tooth: the crown is so worn that the dentine surfaces of the outer and inner columns of the two first ridges have coalesced; and have also united with those of the accessory columns. In the last ridge the internal column is still separate, and the position of the large anterior accessory column<sup>6</sup> (*a*) can still be detected: the hind talon (*ta*) was evidently well developed; and the large tubercles can be seen at the inner extremities of the transverse valleys.

This tooth agrees in all general characters with the corresponding molar of *M. angustidens*; but is intermediate in size between European specimens of m. 1 and

<sup>1</sup> Vacek, 'Abhand. k. k. geol. Reich,' vol. VII, pt. 4, pl. IV, fig. 2

<sup>2</sup> Compare a specimen figured by De Blainville—"Ostéographie," Genus Elephas, pl. XV.

<sup>3</sup> *Supra.*, vol. I., pl. XXV., fig. 4.

<sup>4</sup> Meyer, *op. cit.*

<sup>5</sup> Inferred from the precise similarity in the mineral condition of the two specimens; and from their agreement in size, and their relative condition of wear.

<sup>6</sup> This corresponds to the larger, or posterior, accessory column in the lower teeth.

m. 2.<sup>1</sup> In the Indian tooth, however, the anterior accessory column seems to have been relatively larger; and extended across the median antero-posterior fissure, instead of being confined to its inner side. There appears a certain amount of variation in the degree of development of the accessory tubercles in European specimens of m. 2 of *M. angustidens*<sup>2</sup>; a specimen figured by Kaup<sup>3</sup> being apparently very close to the Indian tooth.

The molar represented in plate IV., fig. 1, is a still more worn specimen of the same tooth: it is slightly wider than the last; but as similar variations obtain among European specimens this difference cannot be considered as of more than individual value. In this much-worn tooth, not only have the dentine surfaces of the separate columns united, but those of the first and second ridges have likewise coalesced; the extremely worn dentine surfaces assuming a regular elliptical shape. Traces of the outer column of the last ridge still persist.<sup>4</sup> Precisely similar conditions of wear obtain in European teeth of *M. angustidens*.<sup>5</sup>

If the two teeth described above be compared with the corresponding tooth of the Siwalik *M. falconeri*,<sup>6</sup> they will be found to differ by their greatly inferior size. They also differ by their smaller hind talon, and the greater development of the anterior accessory column (*a*), and the consequently less regular trefoils formed by the dentine surfaces of the inner columns. The difference in size is indeed so great that the teeth under consideration correspond in this respect with m. 1 rather than m. 2 of *M. falconeri*. An almost unworn molar of that species is represented in vol. I., pl. XXXIII., fig. 3, where it is regarded as m. 1: from its regularly oblong form this tooth is, however, more probably m. 1, of the right side. It exhibits equally well the differences from the teeth under consideration, pointed out in comparing them with m. 2 of the same species. The large fore-and-aft talons are well displayed. From the second true molar of *M. pandionis*<sup>7</sup> the present specimens are likewise distinguished by their greatly inferior size. The crown of the latter (although the different degree of wear of the specimens is not very favourable for comparison) is of a more complex structure, owing to the greater number of accessory columns, and the fine plications into which the enamel is thrown. The form of the worn dentine surfaces is not very unlike in the two; although those of the present species have a greater tendency to a trefoil shape: the tooth of *M. pandionis* is further distinguished by the presence of a large amount of cement. The Bügti teeth agree more nearly in size with m. 1 of *M. pandionis* of which an unworn specimen is represented in plate V., fig. 5: exhibiting well the highly complex crown, with its tall columns. This tooth

<sup>1</sup> Specimens of these teeth in nearly the same condition of wear are figured by Herr Vacek (*op. cit.*, pl. V., figs. 3, 4): they are viewed from the outer side.

<sup>2</sup> Compare Meyer, *op. cit.*, pl. I., fig. 5: pl. III., fig. 7.

<sup>3</sup> "Beiträge," pt. 3, pl. III.

<sup>4</sup> As this tooth might be mistaken for m. 1 of *Dinotherium*, it may be well to point out that it is distinguished from that tooth in *D. indicum* (vol. I., pl. XXXI., fig. 2), by the circumstances that in the latter the dentine surfaces of the ridges assume an irregular shape when most worn: the reverse obtaining in the present teeth. The molar of *Dinotherium* is also distinguished by its much thicker enamel.

<sup>5</sup> Compare Vacek, *op. cit.*, pl. V., fig. 4.

<sup>6</sup> *Supra*, vol. I., pl. XXXII., fig. 1.

<sup>7</sup> *Ibid*, pl. XXXV.

is, however, still less favourable for comparison with the present specimens. A much worn left *m. 1* figured in the first volume (pl. XXXII., fig. 4), as belonging to *M. falconeri*, but which will be shown in the sequel to belong to *M. pandionis*, differs very markedly from the specimens under consideration, with which, from its state of wear, it is very favourable for comparison. In the first place, the crown surface is much more convex antero-posteriorly; while the anterior borders of the worn dentine surfaces are highly convex, instead of nearly straight: and, in the second place, the dentine surfaces of the inner and outer columns coalesce completely in the third ridge before they do in the second; the reverse condition obtaining in the present teeth. Again, the dentine surface of the third ridge of *M. pandionis*, by the absorption of the large double hind talon, becomes much larger than that of either of the others.

In the following table the dimensions of the two specimens under consideration are compared with those of *m. 2* of *M. falconeri*, *M. pandionis*, and *M. angustidens*<sup>1</sup> from Europe:—

	Present specimens.		<i>M. angustidens</i> .		<i>M. falconeri</i> .	<i>M. pandionis</i> .
Extreme length . . .	3.63	3.52	4.52	4.65	5.2	5.1
Width at first ridge . .	2.2	2.42	2.8	2.9	3.5	3.6

A specimen of *m. 2* of *M. angustidens* from Simorre, figured by MM. Lortet and Chantre,<sup>2</sup> has almost precisely the same dimensions as the second Búgti specimen.

*Second lower true molar*.—The tooth represented in pl. IV., fig. 7, and in pl. V., fig. 3, was obtained from Gandoi. It has been scarcely worn; and from its diminishing rapidly in width towards the anterior extremity must be referred to the lower jaw; and belongs to the left side. From its general resemblance to the teeth already described, it must be referred to the same species; while from its agreeing in size with the upper tooth represented in fig. 2 of the same plate, it must in all probability be regarded as the homologous tooth of the lower jaw; or *m. 2*. The crown carries three transverse ridges, a small anterior, and a large posterior talon (*tu*); the latter carrying two columns. The median longitudinal fissure is distinct; and the transverse valleys are broad; the first of these having a low, blunt tubercle (*tu*) at its outer extremity; the posterior accessory columns (*a*) are larger than the anterior (*b*); and in the first valley the former extends slightly on the inner side of the median longitudinal fissure.

In structure this tooth agrees precisely with *m. 2* of *M. angustidens*,<sup>3</sup> although it is possible that the posterior accessory column may be slightly larger. In the form of the hind talon, in which there is a certain amount of variation, it is nearest to a specimen figured by Kaup.<sup>4</sup> In size it is somewhat smaller than European specimens of the corresponding tooth.

From the corresponding tooth of *M. falconeri*<sup>5</sup> the present specimen is

<sup>1</sup> The specimens figured by Meyer.

<sup>2</sup> 'Arch. Mus. Hist. Nat. Lyon,' vol. II., pl. XV., fig. 9a.

<sup>3</sup> Meyer, *op. cit.*, pl. IV., fig. 6: Vacek, *op. cit.*, pl. IV., fig. 2.

<sup>4</sup> "Beiträge," pt. 3, pl. III.

<sup>5</sup> *Supra.*, vol. I., pl. XXXIII., figs. 1, 4.

distinguished by its greatly inferior size, and by the lesser development of the hind talon, which consists of only one row of columns, and is considerably lower than the last ridge. In *M. falconeri*, moreover, the anterior and posterior accessory columns are more equal in size; and the inner column of each ridge shows a tendency to divide into separate cusps, which is not the case in the tooth under consideration.

The corresponding tooth of a small individual of *M. pandionis*<sup>1</sup> is somewhat larger than the present specimen; and is readily distinguished by its more complex hind talon, and accessory columns; of which the anterior and posterior have coalesced to form two large columns situated in the same transverse line, and extending far on either side of the median longitudinal fissure. The transverse valleys are much narrower, and have no tubercles at their outer extremities; and in consequence of this arrangement are blocked to a much greater degree. There is no tendency to the formation of trefoil-shaped dentine islets in *M. pandionis*, and the section of the enamel displays a crenulated arrangement. The first lower molar of *M. pandionis* represented in pl. V., figs. 1, 1a, of this volume, exhibits the much higher and stouter transverse ridges characteristic of that species; as well as the more complex crown, though the latter character is somewhat less marked than in *m. 2* of that species.

The dimensions of the specimen represented in pl. IV., fig. 7, are compared below with those of *m. 2* of *M. angustidens*,<sup>2</sup> *M. falconeri*, and *M. pandionis*.

	Specimen.	<i>M. angustidens.</i>	<i>M. falconeri.</i>	<i>M. pandionis.</i>
Extreme length . . . . .	3.73	4.4	6.4	4.1
Width at first ridge . . . . .	1.82	2.17	3.05	
„ „ third „ . . . . .	2.2	2.68	3.7	2.6
Height of outer column of do. . . . .	1.5			

An homologous tooth of *M. angustidens* from Simorre, figured by MM. Lortet and Chantre,<sup>3</sup> has almost precisely the same dimensions as the Gandoi specimen.

*First lower true molar.*—The specimen represented in pl. IV., fig. 8, is the anterior part of a well-worn left lower true molar; which from its narrower anterior extremity may probably be regarded as the tooth preceding the last specimen, or, the first true molar: if this reference be correct (and it is confirmed by the relative size of *mm. 4* described below) it must have belonged to a somewhat larger individual than that to which the last specimen belonged. A comparison of the figures will show that this specimen agrees in all essential details with the latter: the space occupied by the first and second ridges is, however, rather greater, indicating the more elongated type of the present tooth: the posterior accessory tubercle (*a*) in the first valley is, moreover, relatively larger, its base extending outwards as far as the tubercle at the entrance of the valley: analogous variations occur in *M. angustidens*. The posterior accessory column is rather larger than in any European teeth of *M. angustidens*, which have come under the writer's notice; and the specimen agrees, therefore, in this respect with the last lower molar already described. The points in

<sup>1</sup> *Supra.*, vol. I, pl. XXXIV., fig. 1: the specimen belongs to the opposite side of the jaw.

<sup>2</sup> Vacok, *op. cit.*, pl. IV., fig. 2.

<sup>3</sup> *Op. cit.*, pl. XV., fig. 15.

which this tooth differs from  $\overline{m.1}$  of *M. pandionis* will be alluded to under the head of that species.

The still more worn hinder portion of a right lower molar represented in pl. V., fig. 7, from its being narrower and somewhat smaller than the second true molar described above, may in all probability be likewise regarded as a first true molar. This tooth is of a shorter type than the last specimen; but otherwise agrees with it. It is of very nearly the same size as an homologous upper tooth figured by H. von Meyer<sup>1</sup>; and might have belonged to an individual of the same size as that to which the tooth represented in pl. IV., fig. 1 belonged.

*Fourth lower milk-molar.*—The perfect tooth represented in pl. IV., fig. 5, evidently belongs to the same species as the preceding specimens; and from its small size must be the last milk-molar, probably belonging to an individual of the size of that to which the first true molar represented in fig. 8 of the same plate belonged. It is of nearly the same size as a last milk-molar of *M. angustidens* figured by Kaup,<sup>2</sup> but rather smaller than one figured by MM. Lortet and Chantre.<sup>3</sup> The specimen is in a middle stage of wear; and is almost a miniature facsimile of the tooth represented in fig. 7 of the same plate. It agrees with European specimens of  $\overline{m.4}$  of *M. angustidens*, with the exception of the somewhat larger size of the posterior accessory columns (*a*). The cingulum and the tubercles at the outer extremities of the transverse valleys (*tu*) are particularly well displayed. The length of this tooth is 2.4; its greatest width 1.37; and the height of the worn inner column of the third ridge 0.78 inch. The last lower milk-molar of *M. pandionis*<sup>4</sup> has a higher crown; and a length of 3.4, with a width of 2.3 inches. The corresponding tooth of *M. falconeri* is unknown.

*Last upper premolar.*—At least two types of last upper premolars of trilophodont mastodons are known from the Siwaliks; but as these have never been found associated with the true molars there is very great difficulty in assigning them to their respective species; and their reference must accordingly be considered more or less provisional. In pl. V., figs. 2, 2a, there is represented a tooth from Dera Búgti, which, from certain reasons noted below,<sup>5</sup> and from its resemblance to  $\overline{pm.4}$  of *M. angustidens*, is provisionally referred to the present form. The tooth is in germ; the crown not having become attached to the root. The sub-quadrate shape of the crown indicates that it should be referred to the upper premolar series, of which it must be the last; and the forward inclination of the columns indicates that it

<sup>1</sup> *Op. cit.*, pl. III., fig. 5: the specimen is called the last milk-molar, but is evidently  $\overline{m.1}$ : many of the earlier teeth figured by Meyer are classed one place too early in the series

<sup>2</sup> *Op. cit.*, pt. 3, pl. I., fig. 2.

<sup>3</sup> *Op. cit.*, pl. XV., fig. 4.

<sup>4</sup> *Supra*, vol. I, p. 220.

<sup>5</sup> Since describing the remains of mastodons in the first volume the writer has found out that worn teeth of the premolar series may generally be distinguished from those of the milk-molar series by the fact of the hinder ridge being more worn than the front one; the reverse condition generally prevailing in the milk-molars. Thus the specimen represented in pl. V., fig. 6, from the forward inclination of the ridges is referred to the right side; and consequently from the hind ridge being the most worn, is probably a premolar: the squared form of the crown shows that it belongs to the upper jaw. The cause of the earlier wear of the hind ridge in the premolars is that this part of the tooth comes in contact with the already fully protruded milk, or true molar immediately behind it in the dental series of the opposing jaw.



*Third upper premolar.*—The small germ of a right third upper premolar represented in figs. 4, 4a of pl. V., agrees well in relative size with the last specimen, and may, therefore, not improbably be referred to the same species. This reference is confirmed by the almost complete similarity of the tooth to European specimens of pm. 3 of *M. angustidens*<sup>5</sup>; the difference between the Indian tooth and one of the European specimens figured by H. von Meyer, being not greater than those between the two European specimens figured by the same writer. The Indian and European teeth agree precisely in size.

*Last lower premolar.*—The difficulty experienced in referring the last upper premolars to their respective species is so enhanced in the case of the corresponding lower teeth, that it has been found impossible to arrive at any satisfactory conclusion. In the first volume of this work<sup>6</sup> two small teeth from Sind were provisionally regarded as being the last lower premolars of *M. pandionis*; while a similar tooth, said to have been obtained from the Deccan,<sup>7</sup> was also mentioned; and the three

<sup>1</sup> *Op. cit.*, pl. III., fig. 12.

<sup>2</sup> *Ibid.*, fig. 1: for the serial homology of the tooth of that specimen, see vol. I., p. 200.

<sup>3</sup> For the earlier teeth of this species see below.

<sup>4</sup> *Vide supra*, vol. I, pl. XXXVII, fig. 6, and XL.

<sup>5</sup> Von Meyer, *op. cit.*, pl. III, figs. 1, 8, 9, 10.

<sup>6</sup> Pl. XXXV., fig. 2: p. 221.

<sup>7</sup> This tooth is now in the British Museum (No. 40,787): some remarks on its probable place of origin will be made under the head of the next species.

were shown to be practically indistinguishable from  $\overline{\text{pm. 4}}$  of *M. angustidens*. The more worn condition of the second ridge in some of these teeth seems to indicate that the serial determination is in those cases correct: but it is quite possible that other similar teeth may be milk-molars. Among the specimens obtained by Mr. Blanford from Dera Búgti are two very similar teeth of the left side; one of which is well worn, and is represented in pl. IV., fig. 6; while the other is almost unworn, and is represented in figure 4 of the same plate. The unworn specimen shows the two accessory cusps (*a*, *b*) in the transverse valley; which form a worn disc in the other specimen. In the latter the plane of wear of the last ridge is horizontal; while in the specimen figured in the first volume, and in the one in the British Museum, this plane inclines towards the anterior ridge: a similar inclination existing in the specimen figured in pl. V., fig. 4. It is just possible that this variation may indicate specific or serial differences. The transverse valley in the unworn specimen appears rather narrower than in the others; but none of the five teeth present any characters by which they can be referred to the present, rather than to the next species, or *vice versa*. There is a certain amount of probability that some of these or nearly similar teeth may belong to *M. falconeri*; in which case they may be milk-molars. The dimensions of the two specimens represented in plate IV. are as follows, *viz.*:—

	A 430.	A 431.
Extreme length . . . . .	1.6	1.6
„ width . . . . .	1.34	1.35
Height of inner column of first ridge . . . . .		1.09

*Mandible*.—Among Mr. Blanford's Dera Búgti specimens there is a fragment of the right ramus of the mandible of a mastodon,<sup>1</sup> containing m. 2 and m. 3, with their crowns hammered off. The base of the crown of the latter tooth precisely resembles the last lower molar represented in plate IV., fig. 3, so that there is no doubt that the two should be referred to the same species. The length of the tooth in this jaw must, however, have been slightly greater than that of the detached specimen. The fangs of m. 2 indicate a tooth similar to the specimen represented in pl. IV., fig. 7, but of rather larger size. Below the roots of the molars there is a long cavity, filled with matrix, indicating the presence of large incisors.

From its imperfect condition the mandible, which is broken off a short distance in front of m. 2, has not been figured, but it is of considerable importance in completing the evidence connecting the specimens already described with *M. angustidens*. As far as its imperfect condition admits of comparison, the Búgti mandible agrees precisely with a specimen of the mandible of the latter species figured by Kaup,<sup>2</sup> and was evidently furnished with a similarly produced symphysis: its characteristic points are the straightness of the inferior border, the increase of vertical depth at m. 2 as compared with m. 3, and the great lateral compression. The vertical depth at m. 3 is 5.85, and at m. 2 6.65 inches: the transverse diameter is 4.1 inches.

<sup>1</sup> Ind. Mus., No. A. 435.

<sup>2</sup> Kaup, "Boitragu," pt. 3, pl. 1, fig. 1.

The Búgti jaw is distinguished from the mandible of *M. pandionis*<sup>1</sup> by its inferior size, and by the outer surface being convex, in place of concave<sup>2</sup>: as the symphysis of the former is wanting, it is not possible to make comparisons between that part; but it is probable that the Búgti jaw closely resembled in this respect European specimens of *M. angustidens*. The mandible of *M. falconeri*<sup>3</sup> presents no resemblance to the Búgti specimen.

*Summary.*—As the result of the foregoing comparisons it appears that the present species of mastodon is specifically distinct from both the other Siwalik trilophodonts; but that it agrees so closely with the European *M. angustidens* that there seems no alternative but to refer it to the same species. Since, however, there appears a tendency in the Indian form to a slightly more complex structure of the molars, and to a greater curvature of the borders of the crown of  $\overline{m.3}$ , it may be advisable to mark this local variation by distinguishing the Indian race under the name of *M. angustidens*, var. *paleindicus*.<sup>4</sup> It is noteworthy that in both the above-mentioned respects the Indian race makes a step in the direction of *M. pandionis*.

*Distribution of M. angustidens.*—The species has a wide geographical distribution in Europe; thus it has been found in Gers (Simorre and Sansan), in the south of France; in Switzerland; in Bavaria (Munich); in Styria (Eibiswald); in Bohemia (Franzensbad); and in Austria-Hungary, where it has been recorded from Buda-Pest, from near Staatz, and elsewhere.<sup>5</sup> The specimens from Buda-Pest were obtained from the Sarmatian stage; those from Gers and Styria coming from the so-called mid-miocene. In India the species has been obtained solely on the extreme western side of the continent, where no other Siwalik mastodons, with the exception of *M. pandionis*, are yet known to occur. This probably indicates that the species ranged over the whole of the countries between Europe and the western side of northern India, but did not extend far into that continent. Remains of a mastodon have been recorded from Persia,<sup>6</sup> and it is not impossible that these may eventually turn out to belong to the present species.

From the later tertiaries of N. America a species of trilophodont mastodon has been described under the name of *M. obscurus*,<sup>7</sup> which is considered both by its original describer, and by Herr Vacck,<sup>8</sup> as closely allied to *M. angustidens*: of which it is possible that it may be merely a local race. There appears to be some doubt whether the American species is of miocene, or pliocene age, but it is not improbably the latter.<sup>9</sup> It is noteworthy that the last lower molar of this form has

<sup>1</sup> *Supra.*, vol. I, pp. 216-7.

<sup>2</sup> The writer has not had the opportunity of putting the two specimens in juxta-position: if this were done it is probable that other differences would be detected.

<sup>3</sup> *Supra.*, vol. I, pp. 207-8, pl. XXXIII., fig. 1.

<sup>4</sup> The term *indicus* would have been preferable, but as the writer is persuaded that the elephants and mastodons will eventually have to be united in one genus, it might lead to confusion.

<sup>5</sup> This distribution has been mainly taken from Herr Vacck's memoir, already cited

<sup>6</sup> Introduction to vol. II.

<sup>7</sup> Leidy, "Extinct Vertebrate Fauna of the Western Territories," pls. XXI-XXII

<sup>8</sup> *Op. cit.*, p. 24.

<sup>9</sup> Herr Vacck alludes to it as undoubtedly of pliocene age: in the first volume of the present work it is doubtfully referred to the miocene

the accessory columns relatively small, and the lateral borders nearly straight; indicating that while farthest removed in space, it is likewise farthest removed in structure from the Indian race.

The circumstance that the Indian race apparently marks the extreme eastern range of the species, and the occurrence of an allied form in America, seem to lead to the conclusion that the original home of the group was in Europe or Western Asia: from whence it migrated east and west.

Species 2: MASTODON (TRILOPHODON) PANDIONIS, Falconer.

*Introductory.*—In the first volume of this work<sup>1</sup> a considerable series of the teeth and jaws of the present species are described and figured. Many of these specimens were obtained from the Siwaliks of the Punjab, and others from Sind; but all the type specimens were said to have been obtained from the Deccan, by Col. Sykes. An examination of these specimens, which are now in the British Museum,<sup>2</sup> has, however, shown that in mineralogical condition they correspond precisely with the Siwalik fossils of Sind; exhibiting the characteristic gray weathered surface of the enamel. Among Col. Sykes' specimens having the same reputed origin there is the small tooth<sup>3</sup> represented in woodcut fig. 6, provisionally referred to *M. falconeri*, which precisely agrees with another specimen presented by Col. Sykes to the British Museum (No. 32,503), and obtained from Sind. The only region in the Deccan where mammalian remains have been obtained, is the valley of the Krishna, and it has been suggested<sup>4</sup> that Col. Sykes' specimens were obtained from the upper part of that valley. The Krishna valley fossils are, however, in an extremely fragile and unmineralized condition; whereas Col. Sykes' specimens are very hard and stony. There are the additional circumstances that the Krishna deposits are of pleistocene age, while in Sind the remains of *M. pandionis* occur in the lower Siwaliks; and that no strata equivalent to the Siwaliks are known in southern India. For these reasons, and especially since it is certain that one mastodon molar, precisely similar to one of the reputed Deccan specimens, was obtained by Col. Sykes from Sind, it appears to the present writer to be highly probable that the whole of his specimens were obtained from the latter region.<sup>5</sup>

*First upper true molar.*—The specimen represented in pl. V., fig. 5, is the one alluded to in the first volume (p. 214) as being a first upper molar of which the locality is unknown. At that time it was thought to be distinct from the specimen described in the note by Dr. Falconer quoted on pp. 213, 214 of the same volume as

<sup>1</sup> Pp. 213, 292: pls. XXXIV.-XXXVI.

<sup>2</sup> One of these specimens is represented in plate V., fig. 5. All the specimens are stated in the "Palæontological Memoirs" to have been presented to the India House by Col. Sykes: the figured specimen was, however, found in Falconer's private collection.

<sup>3</sup> B. M., No. 40,788.

<sup>4</sup> "Manual," pt. I., p. 390.

<sup>5</sup> It is just possible that the confusion may have arisen in the following manner:—It was known that Col. Sykes obtained a large collection of mesozoic fossils from the Deccan, and if the mastodon remains were not fully labelled, nothing is more likely than that they should have been assigned to the same locality.

the penultimate upper molar, but a subsequent comparison with that description has shown that it is really the same.<sup>1</sup> A comparison with the figure of m. 2 given in plate XXXVA. of the first volume, will show that it is really the first upper true molar of the left side. Nothing need be added to Falconer's description, except that traces of cement are to be seen in the transverse valleys; and that the columns are relatively higher than in *M. angustidens*, and the enamel is thrown into vertical corrugations. The length of the specimen is 4, and its extreme width 2·5 inches.

In pl. XXXII., fig. 4, of the first volume of this work a much-worn upper true molar of a trilophodont mastodon from the Punjab, is figured as m. 1 of *M. falconeri*, although it was noticed<sup>2</sup> that it differed from the other true molars of that species in having irregular, instead of trefoil-shaped, dentine islets. It now appears from a comparison with the figure of m. 2 of *M. pandionis* given in plate XXXVA.<sup>3</sup> of the same volume, as well as from the crenulated edges of the enamel, the obliquity of the valleys, and the forward inclination of the ridges in the much-worn molar, that the latter should likewise be referred to *M. pandionis*; of which it is m. 1. It differs widely from the specimen now regarded as m. 1 of *M. falconeri*<sup>4</sup>; in which species the enamel of the true molars is smooth,<sup>5</sup> the columns of the ridges nearly upright, and the valleys run straight across the crown.

*First lower true molar.*—The specimen represented in plate V., figs. 1, 1a, was obtained by Mr. Blanford from Dera Búgti; and from its narrow shape and the three ridges borne on the crown is evidently the lower molar of a trilophodon, belonging to the left side of the jaw. The crown is still in germ, being untouched by wear; and has lost a small portion of its postero-external angle. The columns of the ridges and talons are taller than in the first and second lower molars of *M. angustidens* (pl. IV., figs. 7, 8: pl. V., figs. 3, 7); and the transverse valleys are narrower and more blocked. The accessory columns are, moreover, much more numerous; and consist of a confused agglomeration in each transverse valley, instead of a pair only: there is also an extra one of these columns wedged in between the hind talon (*ta*) and the outer column of the last ridge. The enamel, instead of being smooth as in *M. angustidens*, is thrown into vertical corrugations; which in a worn condition would give a crenulated appearance to the rings of enamel surrounding the dentine islets. From the appearance of the enamel in the valleys it seems probable that cement was originally present in considerable quantities. The length of this specimen is 4·1, the extreme width 2·25, and the height of the inner column 2·0 inches.

<sup>1</sup> The identification was not easy to make without a comparison of the actual specimen with Falconer's description.

<sup>2</sup> *Supra*, vol. I., p. 208, note.

<sup>3</sup> This specimen was obtained after the smaller tooth had been described and figured: and exhibits more clearly than previous specimens the corrugated enamel as a well-marked specific character. In describing it at the end of the first volume the writer was on the point of departure for the field, and had not time to make a full comparison with other specimens; which would have shown that the smaller tooth belonged to the same species.

<sup>4</sup> Vol. I., pl. XXXIII., fig. 3.

<sup>5</sup> The milk-molars with rough enamel figured in vol. I., pl. XXXII., and referred to *M. falconeri* will be alluded to under the head of that species.

In all the above-mentioned characters this specimen agrees with the teeth of *M. pandionis*; and as it has precisely the same dimensions as the right m. 1 of that species represented in plate XXXV., fig. 1, of the first volume, it may safely be regarded as the homologous tooth of the opposite side.<sup>1</sup>

*Upper premolar.*—The tooth represented in figs. 6, 6a of plate V., and the one in the woodcut (fig. 5), are two of three similar specimens from Dera Búgti. The former has lost the greater part of the cingulum, and the inner face of the first inner column, and is less worn than the latter specimen. The sub-quadrate form of the crown shows that the specimens belong to the upper jaw; while the forward inclination of the larger columns (fig. 6a) indicates that they are from the right side. The absence of a disc of pressure on the anterior side, the rounded angles of the crown, and the more worn condition of the hinder as compared with the front columns, indicates that the teeth belong to the premolar series, of which they are the last.



Fig. 5. (?) *Mantodon pandionis*, Falc. Last right upper premolar, from Dera Búgti: Indian Museum (No. A. 432). †.

From the strongly-marked vertical corrugations in the enamel, the forward inclination of the columns, and the obstructed transverse valleys, it is inferred that these specimens probably belong to the present species. Their distinction from the corresponding tooth referred to *M. angustidens* (pl. V., figs. 2, 2a) will be sufficiently apparent from a comparison of the figures: and from their complex crowns, as well as from the absence of *M. fulconeri* from Dera Búgti, it is improbable that they belong to that species. The present teeth are of relatively smaller size when compared with the true molars of *M. pandionis*, than is the case with the corresponding teeth of *M. angustidens*.

*Affinities.*—The affinities of the present species have been already alluded to in the first volume,<sup>2</sup> but a few remarks may be added. That the species is allied to *M. angustidens* is pretty evident from the general form of the mandible, and the structure of the molars. The greater complexity of the latter, and the addition of cement, indicates, however, that the present species is a more specialized form, and may possibly have sprung from the progenitors of the Indian race of *M. angustidens*, which has been shown to diverge somewhat from the typical race in the direction of the present species. The absence of *M. pandionis* from the Eastern Siwaliks indicates the probability of its being an immigrant into India from the west; which confirms its relationship to *M. angustidens*. From the coexistence of the two forms in the lower Siwaliks of Dera Búgti their genetic connection probably took place in the regions to the westward of India. *M. pandionis* appears to have survived longer, and penetrated further into India than *M. angustidens*, since its remains occur abundantly in the upper Siwaliks of the Punjab to the westward of the river Jhelam.

The circumstance that the last molars of the upper Siwalik *M. sivalensis* have a

<sup>1</sup> The specimen figured in the first volume is narrower posteriorly, but this is probably due to its imperfect protrusion.

<sup>2</sup> P. 225, *et. seq.*

great resemblance to those of the lower Siwalik *M. pandionis*,<sup>1</sup> coupled with the fact of the former having a short, and the latter a long mandibular symphysis,<sup>2</sup> might lead to the inference that the one is the more specialized descendant of the other; but the absence of cement in *M. sivalensis* seems to forbid this view. From the extreme complexity of the structure of its molars, *Mustodon pandionis* can have no direct ancestral connection with the true elephants.

Species 3: MASTODON (TRILOPHODON) FALCONERI, *nobis*.

*Upper milk-molars*.—In figs. 2, 3 of plate XXXII. of the first volume an associated penultimate and last upper milk-molar of a trilophodont mastodon were referred to *M. falconeri*: the specimens belonged to a young cranium, associated with a part of the mandible containing mm. 3.<sup>3</sup> It was not noticed that these teeth differed from the true molars of that species by the enamel being thrown into vertical corrugations.<sup>4</sup>



Fig. 6. (?) *Mastodon falconeri*, *nobis*.  
Third right upper milk-molar (?):  
British Museum (No. 40,788). 1.

In the accompanying woodcut (fig. 6) there is represented a right upper tooth of a trilophodont mastodon, said to have been obtained by Col. Sykes from the Deccan, but which is more probably from Sind<sup>5</sup>; there being a precisely similar specimen from that district presented by Col. Sykes to the British Museum (No. 32,503.) The figured specimen carries two transverse ridges, both of which are nearly equally worn: the columns of the ridges are nearly vertical; and there are accessory columns on either side of the inner main columns, causing the worn dentine surfaces of the latter to assume a trefoil shape. The enamel is smooth, and the transverse valleys are fairly open. From the columns of the first ridge being more worn than those of the second, and the elongated and angular shape of the crown, the tooth under consideration is inferred to be mm. 3, rather than pm. 4. It is unlike mm. 3 of *M. angustidens*,<sup>6</sup> and is of too large a size to have belonged to the Indian race of that species. It differs from the teeth of *M. pandionis* in its smooth enamel, low vertical ridges, wide transverse valley, and trefoil-shaped dentine islets. A tooth of quite a different type, represented in vol. I., pl. XXXV., fig. 3, is, from the presence of cement in its valleys, considered with great probability to be the homologous milk-molar of the last-named species.

With the true molars of *M. falconeri* the present tooth agrees in all respects, and there is accordingly a great probability of its belonging to that species. If this

<sup>1</sup> *Vide supra*, vol. I., p. 226.

<sup>2</sup> From the occurrence of a short symphysis in all the true elephants, and stegodons, and in the pleistocene mastodons, it may be taken as certain that this form of jaw is the most specialized.

<sup>3</sup> *Supra.*, vol. I., pl. XXXIII., fig. 2.

<sup>4</sup> The specimen represented in vol. I., pl. XXXII., fig. 4, being referred to *M. falconeri* (instead of *M. pandionis*) rendered this character inconstant.

<sup>5</sup> *Vide supra.*, p. 29.

<sup>7</sup> *Supra.*, vol. I., pl. XXXIII., fig. 4.

<sup>6</sup> Gaudry "Enchainements - Mam. Tert.," fig. 230 (2m.).

be so, the milk-molars mentioned above, and figured in plate XXXII. of the first volume, cannot belong to that species. Those teeth do not, moreover, belong to *M. angustidens*; and, for the reason mentioned above it is improbable that they belong to *M. pandionis*. This is confirmed by the valleys of mm. 4 (vol. I., pl. XXXII., fig. 3) having no cement, being straight and very open, and the ridges low and nearly vertical. The cranium in which these milk-molars, together with m. 1, are contained, shows, moreover, no signs of the presence of premolars,<sup>1</sup> which there is every reason to believe were developed in *M. pandionis*, as in *M. angustidens*. On this view it seems highly probable that the milk-molars referred in the first volume to *M. falconeri*, really belong to a fourth Siwalik species of trilophodont mastodon.<sup>2</sup>

The only other interpretation of the serial homology of the tooth represented in woodcut fig. 6, would be to consider it as pm. 4. In that case it could not belong to either *M. angustidens*, or *M. pandionis*, of which the corresponding teeth are known (pl. V.): and if it belonged to *M. falconeri*, then the milk-molars referred to that species in the first volume would have been succeeded by premolars, which was apparently not the case. It is, moreover, improbable, even if they were so succeeded, that they should be replaced by a tooth furnished with an entirely different kind of enamel: and on this view it thus seems probable that the above-mentioned milk-molars belong to a new species.

From the resemblance of the tooth represented in woodcut fig. 6 to the lower teeth of the type of those represented in plate V., figs. 4 and 6, it is not impossible that some of those in which the first ridge is the most worn may be the homologous lower milk-molars of *M. falconeri*.

Before there can be any hope of deciding as to the existence of a fourth species of Siwalik trilophodont mastodon, and of arriving at a satisfactory conclusion as to the exact serial and specific position of many of the above-mentioned teeth, it is absolutely necessary that skulls or jaws should be obtained showing some of these teeth in juxtaposition with the true molars, or last milk-molars. Every specimen of the jaws of young individuals of mastodons from Sind and the Búgti Hills promises, therefore, to be of the highest interest, and should stimulate all those who have the opportunity to the collection of fossils from those regions.

*Number of teeth known.*—As the serial position of one of the teeth of this species figured in the first volume has been changed; and as other teeth there referred to the same species have been shown to be either probably or certainly specifically distinct, it may be well to give a revised list of the known teeth; *viz.*

(?) Mm. 3—Woodcut fig. 6, p. 32.

M. 1 —Vol. I., pl. XXXIII., fig. 3.

M. 2 —*Ibid.*, pl. XXXII., fig. 1.

M. 2 —*Ibid.*, pl. XXXIII., fig. 4.

<sup>1</sup> *Ibid.*, p. 208.

<sup>2</sup> The talons of the tooth represented in vol. I., pl. XXXII., fig. 3, are smaller than those of the tooth now regarded as m. 1 of *M. falconeri* (*Ibid.*, pl. XXXIII., fig. 3.)



*Distribution.*—Unless the specimen represented in woodcut fig. 6 really came from the Deccan, the present species is confined to the Siwaliks of the western Punjab and the lower Siwaliks of Sind. In both regions its remains are tolerably abundant, although complete teeth are rare.

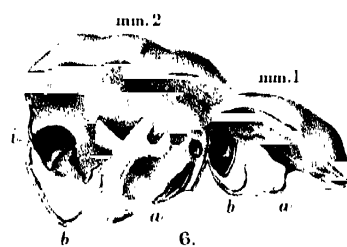
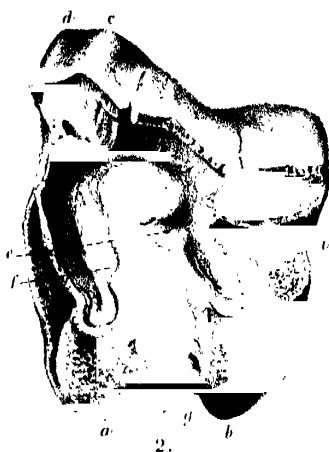


## PLATE I.

### PERISSODACTYLA — *Rhinocerotidae*.

- Fig. 1. ACERATHERIUM BLANFORDI, var. MAJUS, Lyd. Part of left maxilla, containing the three true molars, in a well-worn condition; from the lower Siwaliks of Dera Búgti: Indian Museum (No. C. 268).
- „ 2. ACERATHERIUM BLANFORDI, var. MAJUS, Lyd. Second left upper true molar, somewhat less worn than the corresponding tooth of the last specimen; from the lower Siwaliks of Gandoi, Búgti Hills: Indian Museum (No. C. 259).
- „ 3. RHINOCEROS SIVALENSIS, Falc. and Caut., var. INTERMEDIUS, Lyd. Right upper true molar, slightly worn; from the lower Siwaliks of Sind: Indian Museum (No. C. 34). (*Vol. II., pl. V., fig. 2.*)
- „ 4. RHINOCEROS SIVALENSIS, Falc. and Caut., var. GAJENSIS, Lyd. First or second right upper true molar, partly broken; from the Gáj group of Sind: Indian Museum (No. C. 36). (*Vol. II., pl. V., fig. 7.*)
- „ 5. ACERATHERIUM PERIMENSE, Falc. and Caut. Second left upper true molar, well worn; from the Siwaliks of Burma: Indian Museum (No. C. 74). (*Vol. I., pl. V., fig. 1. R. iravadicus.*)
- „ 6. ACERATHERIUM BLANFORDI, Lyd. First and second right upper milk-molars, from the lower Siwaliks of Gandoi: Indian Museum (No. C. 260).
- „ 7. RHINOCEROS SIVALENSIS, Falc. and Caut. (type form). Second left upper true molar, from the Siwaliks of the Punjab: Indian Museum (No. C. 23). (*Vol. I., pl. V., fig. 5.*)

\* All the figures natural size. *a*, anterior collis: *b*, posterior collis: *c*, second costa: *d*, first costa: *e*, crochet: *f*, ante-crochet: *g*, entrance of median valley: *i*, posterior valley.





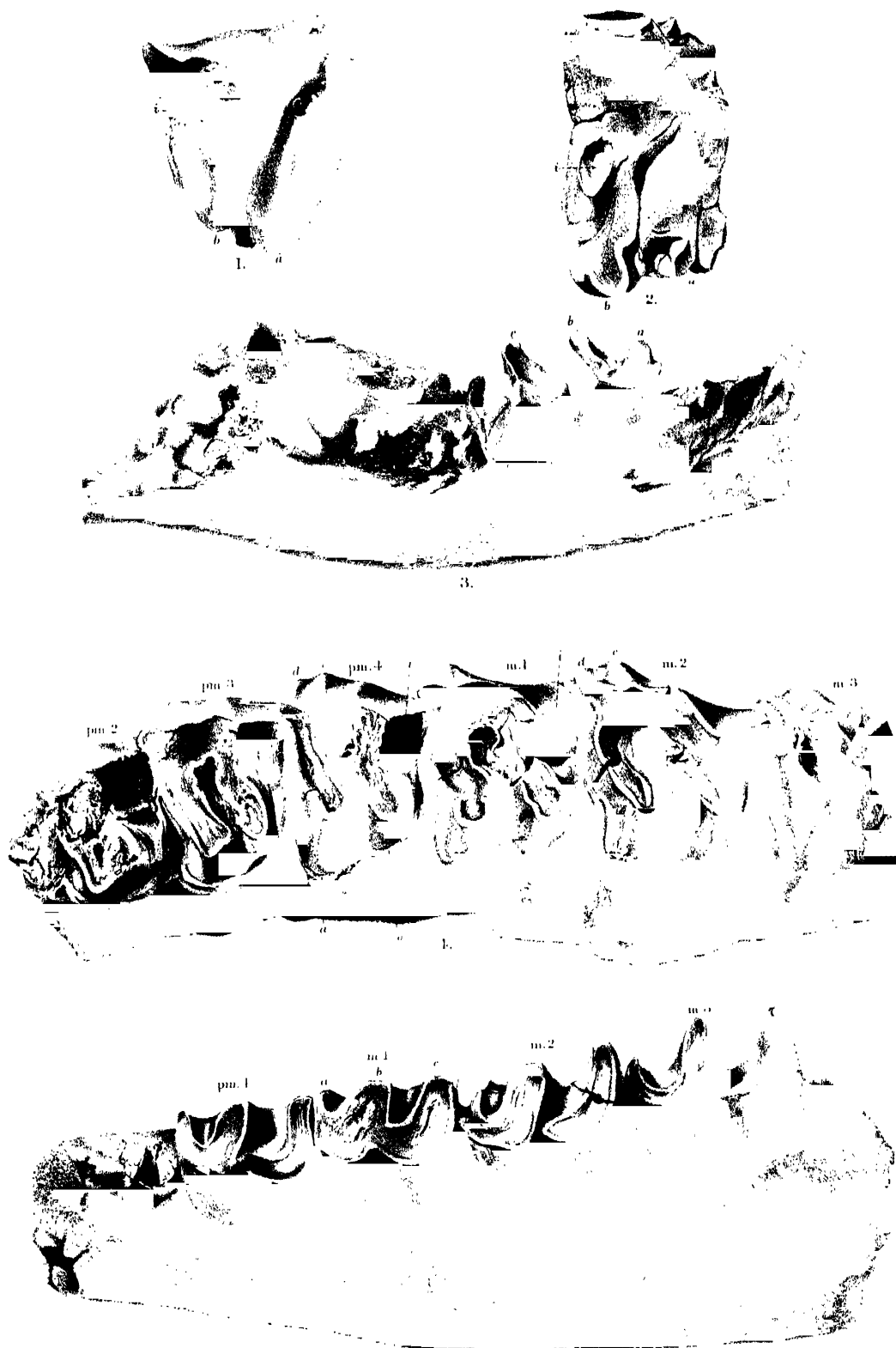


## PLATE II.

### PERISSODACTYLA — *Rhinocerotidae*.

- Fig. 1. ? ACERATHERIUM BLANFORDI, Lyd. Last right upper milk-molar (?) in germ ; Indian Museum (No. C. 258).
- „ 2. ACERATHERIUM BLANFORDI, Lyd. Third right upper true molar, very much worn : Indian Museum (No. C. 262).
- „ 3. ACERATHERIUM BLANFORDI, Lyd. Part of right ramus of mandible of a calf, containing one milk-molar : Indian Museum (No. C. 267).
- „ 4. ACERATHERIUM BLANFORDI, var. MINUS, Lyd. Left maxilla, with the teeth in a medium condition of wear : Indian Museum (No. C. 269).
- „ 5. ACERATHERIUM BLANFORDI, var. MINUS, Lyd. Part of left ramus of mandible, belonging to the same individual as the last : Indian Museum (No. C. 270).

\* All the specimens were obtained from the lower Siwaliks of Gandoi, Búgti Hills ; and are figured of the natural size. Lettering of upper teeth the same as in plate I. In fig. 3, *a*, anterior extremity of first crescent : *b*, posterior extremity of same : *c*, posterior extremity of second crescent.









## PLATE III.

PERISSODACTYLA — *Equide*.

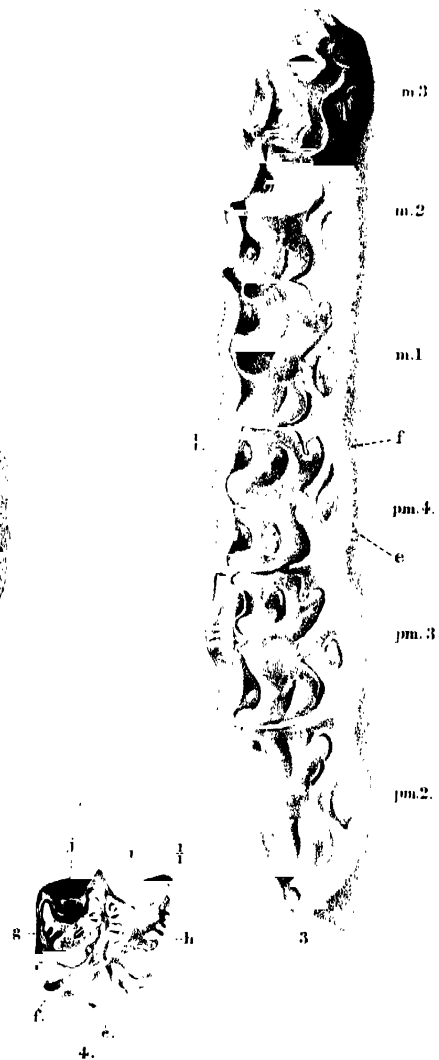
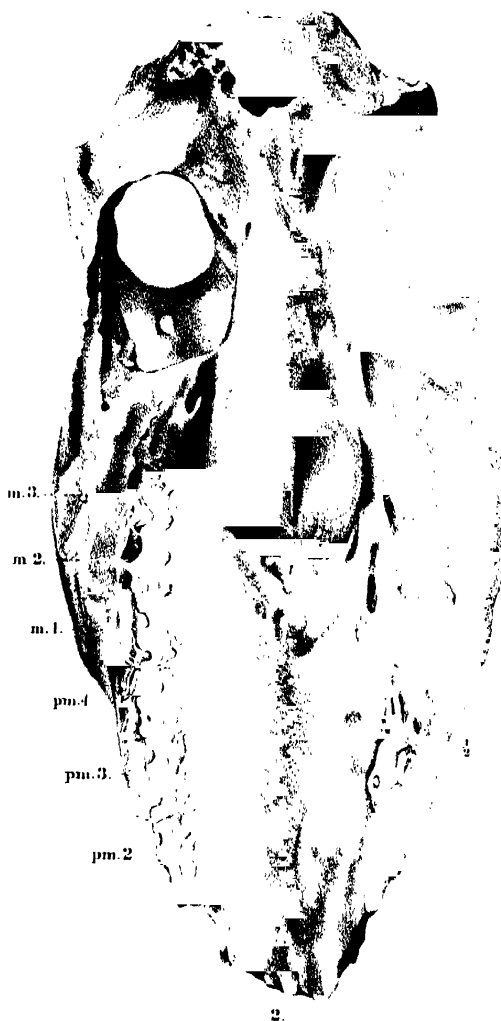
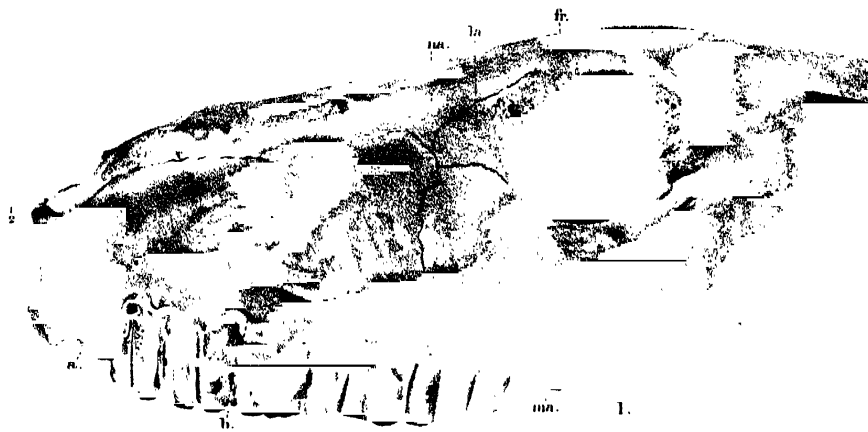
HIPPOTHERIUM ANTILOPINUM, Falc. and Caut.

Figs. 1, 2. Cranium, from Perim Island, Gulf of Cambay ; in the possession of Mr. Theodore Cooke, of Poona. 1 from the left lateral, 2 from the palatal aspect.

„ 3. The cheek-teeth of the left side of the same specimen.

„ 4. Polished section of a tooth of the cheek-series of the right side ; from the Punjab.

\* Figs. 1, 2, one-half natural size : the others natural size : the specific determination of fig. 4 is provisional. In fig. 1, *a*, anterior maxillary cavity : *b*, posterior ditto : *na*, nasal : *la*, lachrymal : *fr*, frontal : *ma*, malar. In figs. 3, 4, *e*, anterior pillar : *f*, posterior ditto : *g*, lamina connecting first crescents : *h*, lamina connecting second ditto : *i, j*, cement islets.







## PLATE IV.

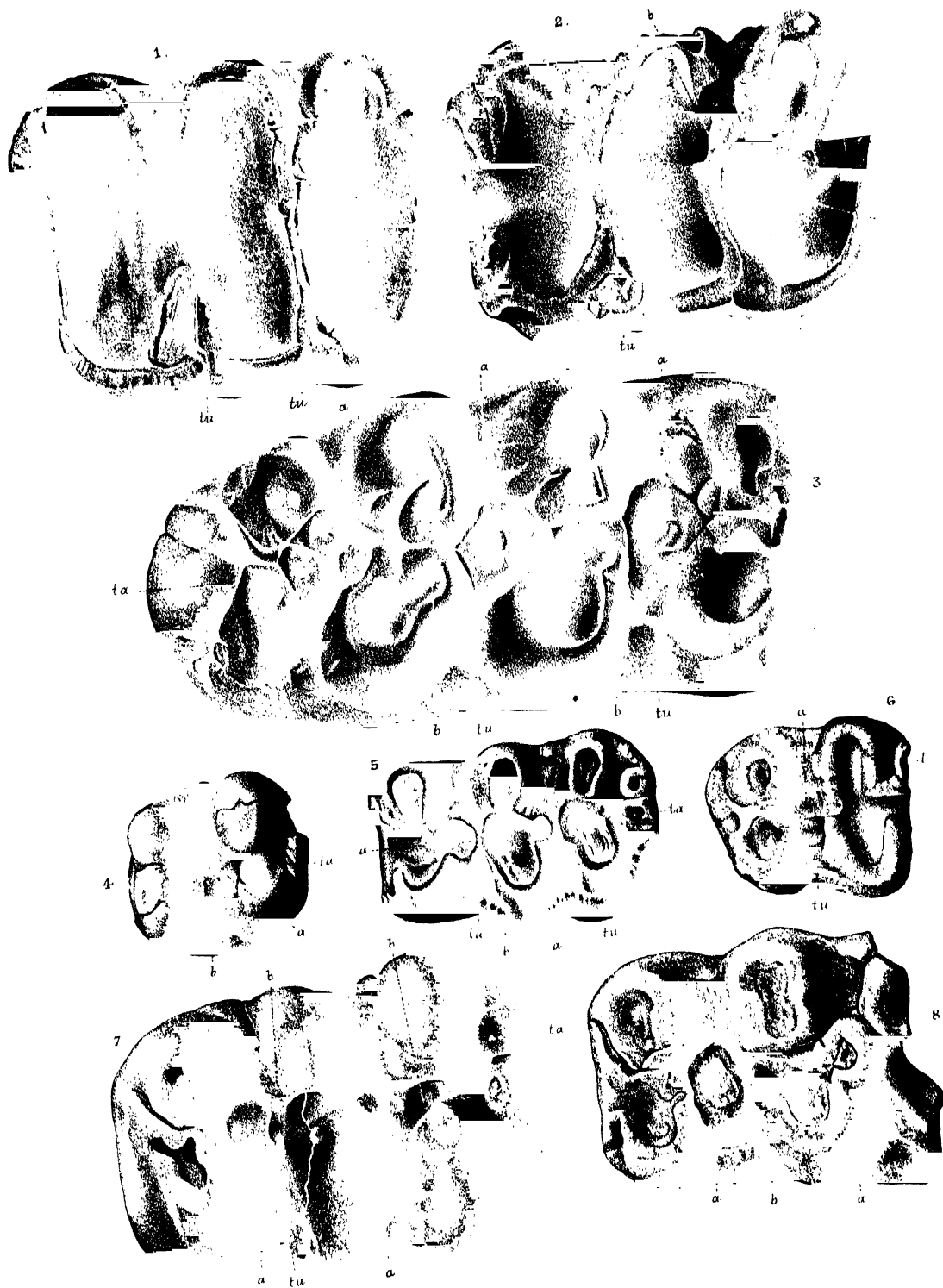
PROBOSCIDA — *Elephantidae*.

*MASTODON ANGUSTIDENS*, Cuv., var. *PALÆINDICUS*, Lyd.

- Fig. 1. Second left upper true molar, in a much worn condition : Indian Museum (No. A. 427).  
,, 2. Second left upper true molar, in a less worn condition than the last specimen : Indian Museum (No. A. 425).  
,, 3. Third right lower true molar, associated with the last specimen, in a medium stage of wear : Indian Museum (No. A. 426).  
,, 4. (?) Fourth left lower premolar, scarcely worn : Indian Museum (No. A. 431).  
,, 5. Fourth left lower milk-molar, in a medium stage of wear : Indian Museum (No. A. 422).  
,, 6. (?) Fourth left lower premolar, in a medium stage of wear : Indian Museum (No. A. 430).  
,, 7. Second left lower true molar, in a very early stage of wear ; Indian Museum (No. A. 423.)  
,, 8. First left lower lower true molar, in a medium stage of wear : Indian Museum (No. A. 421).

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\* The specific reference of figs. 4 and 6 is open to a considerable amount of doubt—Fig. 7 was obtained from the lower Siwaliks of Gandoi, Búgti Hills ; all the others came from the same deposits of Dera Búgti. All the figures are of the natural size ; the upper teeth being viewed from the inner, and the lower from the outer side of the grinding surface ; *a*, larger accessory column (posterior in lower, and anterior in upper teeth) ; *b*, smaller do. (anterior in lower, and posterior in upper teeth) ; *ta*, hind talon ; *tu*, tubercle at extremities of transverse valleys (outer in lower, and inner in upper teeth).









## PLATE V.

### PROBOSCIDIA — *Elephantidæ*.

- Figs. 1, 1a. **MASTODON PANDIONIS**, Falc. First left lower true molar, in an unworn condition : Indian Museum (No. A. 424) ; 1 from the grinding surface, 1a from the outer side.
- „ 2, 2a. (?) **MASTODON ANGUSTIDENS**, Cuv., var. **PALÆINDICUS**, Lyd. Germ of fourth right upper premolar : Indian Museum (No. A. 429) : 2 from the grinding surface, 2a from the outer side.
- „ 3. **MASTODON ANGUSTIDENS**, Cuv., var. **PALÆINDICUS**, Lyd. Outer aspect of specimen represented in plate IV., fig. 7.
- „ 4, 4a. (?) **MASTODON ANGUSTIDENS**, Cuv., var. **PALÆINDICUS**, Lyd. Third right upper premolar, in germ : Indian Museum (No. A. 428) : 4 from the grinding surface, 4a from the outer side.
- „ 5. **MASTODON PANDIONIS**, Falc. First left upper true molar, in a very early stage of wear : British Museum (No. 40,818).
- „ 6, 6a. (?) **MASTODON PANDIONIS**, Falc. Fourth right upper premolar, in an early stage of wear : Indian Museum (No. A. 433) : 6 from the grinding surface, 6a from the outer side.
- „ 7. **MASTODON ANGUSTIDENS**, Cuv., var. **PALÆINDICUS**, Lyd. Part of first right lower true molar, in a well-worn condition : Indian Museum (No. A. 417).

\* Fig. 3 is from Gandoi, Búgti Hills : fig. 5 is stated to be from the Deccan, but is more probably from Sind : all the others are from Dera Búgti. All the figures are of the natural size : and the teeth, which are viewed from the grinding surface, are placed in the same position as in the preceding plate. The lettering of all the figures, except fig. 2, is the same as in the latter : the lettering of fig. 2 is explained in the text.

